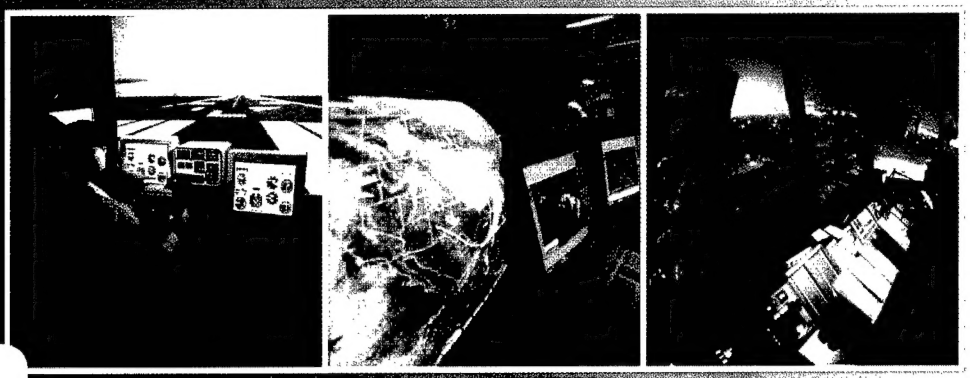
1997

Federal Aviation Administration Plan for Research, Engineering, & Development



January 1997

Report of the Federal Aviation Administration to the United States Congress pursuant to 49 United States Code 44501(c).

U.S. Department of Transportation
Federal Aviation Administration

Cover:

Front Inserts

First Row From Left To Right:

- Basic General Aviation Research Simulator Laboratory at the Civil Aeromedical Institute which ensures technological advances are consistent with capabilities of general aviation pilots to assimilate new technology.
- Meteorologist weather processor used to display weather products for FAA and air traffic use.
- View from air traffic control.

Second Row From Left To Right:

- Research subject performing synwork cognitive function task in evaluation of hypoxia in Civil Aeromedical Institute altitude chamber.
- Protection and survival laboratory at the Civil Aeromedical Institute.
- The vivid–rapid detection system Model H1 being evaluated by members of the Bulk Explosives Detection Program in the Aviation Security Laboratory at the William J. Hughes Technical Center.

Third Row From Left To Right:

- Test used for full–scale fire test inside building.
- FAA flight crew participating in helicopter hoist simulation at the Civil Aeromedical Institute survival tank.
- Research using the new B747 aircraft cabin evacuation simulator to evaluate evacuation slide testing methods.

Back Inserts

From Top To Bottom:

- Cessna in flight.
- Federal Aviation Administration test of the pavement arresting system.
- Advisory material on cosmic radiation has been prepared in collaborative efforts between FAA researchers and the airline industry.

Photos courtesy of FAA Technical Center, Civil Aeromedical Institute, and TRW SETA Library.

1997

Federal Aviation Administration Plan for Research, Engineering, & Development

For further information
or questions concerning the
1997 FAA Plan for Research, Engineering and Development,
write to:

Federal Aviation Administration
ASD–400
800 Independence Avenue, SW
Washington, DC 20591

or call an ASD representative at
(202) 358–5402

This document may be purchased from
The National Technical Information Service (NTIS).
Write the NTIS sales desk,
5285 Port Royal Road
Springfield, Virginia 22161
Fax (703) 321–8547, or phone the sales desk,
(703) 487–4650 or 1–800–553–6847

The R,E&D Plan is also available on the Internet at:
http://www.nasi.hq.faa.gov/nasipubs.htm

Table of Contents

LIST OF FIGURES

LIST OF TABLES

1.0 OVERVIEW

1.1 Introduction To The Research, Engineering and Development Program

Purpose

The Federal Aviation Administration (FAA) Plan for research, engineering and development (R,E&D) is published in response to statutory requirements to provide an annual report to Congress on the FAA's R,E&D program to ensure continued safety, security, capacity, and efficiency of aviation in the United States.

The research programs selected for inclusion in the R,E&D program portfolio are those needed to bring the FAA's vision of the future system to reality in the context of a continuing top-level system engineering process. The FAA's R,E&D program has received contributions from across the spectrum of scientific, operational, and user communities. These contributions from both inside and outside government are always welcome, provide valuable inputs, and are greatly appreciated.

Scope

The 1997 R,E&D Plan is a calendar-year plan and contains programs that are active in calendar year 1997 and beyond. The R,E&D milestones included in this Plan are based on projected funding levels during a 5-year planning horizon.

Note: The universities and contractors listed in the program descriptions throughout the Plan were supporting research activities in 1996. This listing does not imply any future funding commitment.

Document Organization

R,E&D program descriptions have been grouped into nine thrust areas: Capacity and Air Traffic Management Technology; Communications, Navigation, and Surveillance; Weather; Airport Technology; Aircraft Safety Technology; System Security Technology; Human Factors and Aviation Medicine; and Environment and Energy. These thrust areas offer a logical grouping of related programs based on common research focus attributes. Research efforts from programs within these tactical thrust areas support the FAA's broader, high-level statutory mission which can be grouped into five statutory mission areas: Safety, Security, Capacity, Environment, and Efficiency.

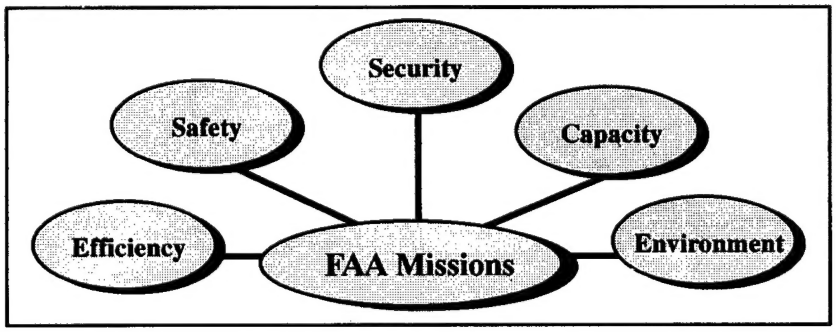


Figure 1-1. Mission Areas

These mission areas correspond to those in the Federal Aviation Administration Research, Engineering & Development and Facilities & Equipment Appropriations, Fiscal Year 1998 Annual Performance Plan, the FAA's response to The Government Performance and Results Act of 1993 [Public Law 103–62]. The efficiency mission area incorporates industry vitality and business practices/productivity. The full range of six categories will be used in the future as research expands in the business practices/productivity area.

Safety: The safety mission area includes the range of FAA activities that minimize the chance of injury or death and damage or loss of property due to accidents/incidents within the civil aviation system. Major safety components include aircraft, airports, airways, procedures, and human performance.

Security: The security mission area includes the range of FAA activities that minimize the chance of injury or death of people or damage or loss of property due to acts of terrorism that may be directed to the civil aviation system. The major components are aircraft, airports, airways, procedures, and human performance.

Capacity: The capacity mission area encompasses the range of FAA activities that increase and maintain the ability of the civil aviation system to govern the flow of traffic. Activities in this mission area provide for maximizing aircraft throughput while minimizing delay in the face of increasing demand for services or adverse weather. This area includes actions to manage demand in the system through flow control. Capacity components include aircraft, airports, airways, airspace management, and procedures.

Environment: The environment mission area encompasses the range of FAA activities that minimize injury, damage, disruption, and unacceptable levels of intrusion imposed on the nation's environment resulting from the operations of the civil aviation system. Some major components of this mission area relate to aircraft emissions, building and operation of facilities, and storage and disposal of contaminants.

Efficiency: The efficiency mission area includes the range of FAA activities that minimize the costs to all users of the National Airspace System (NAS) of actions undertaken or proposed by the FAA. It also includes the range of FAA activities that increase the ability of the FAA to operate on reduced financial resources without reducing the system operational safety, security and capacity. Activities in this area are those that enable the FAA to operate the NAS at reduced cost and staffing. Additionally, this area includes activities focusing on improving FAA business practice, transforming the internal FAA workplace into a federal model, and improving internal communications within the work force. Major components include air traffic, inspection and certification, and system development.

Figure 1–2 shows the set of R,E&D programs that contribute to the FAA missions listed by budget reference numbers. A full description of these programs can be found in chapters 2 through 9.

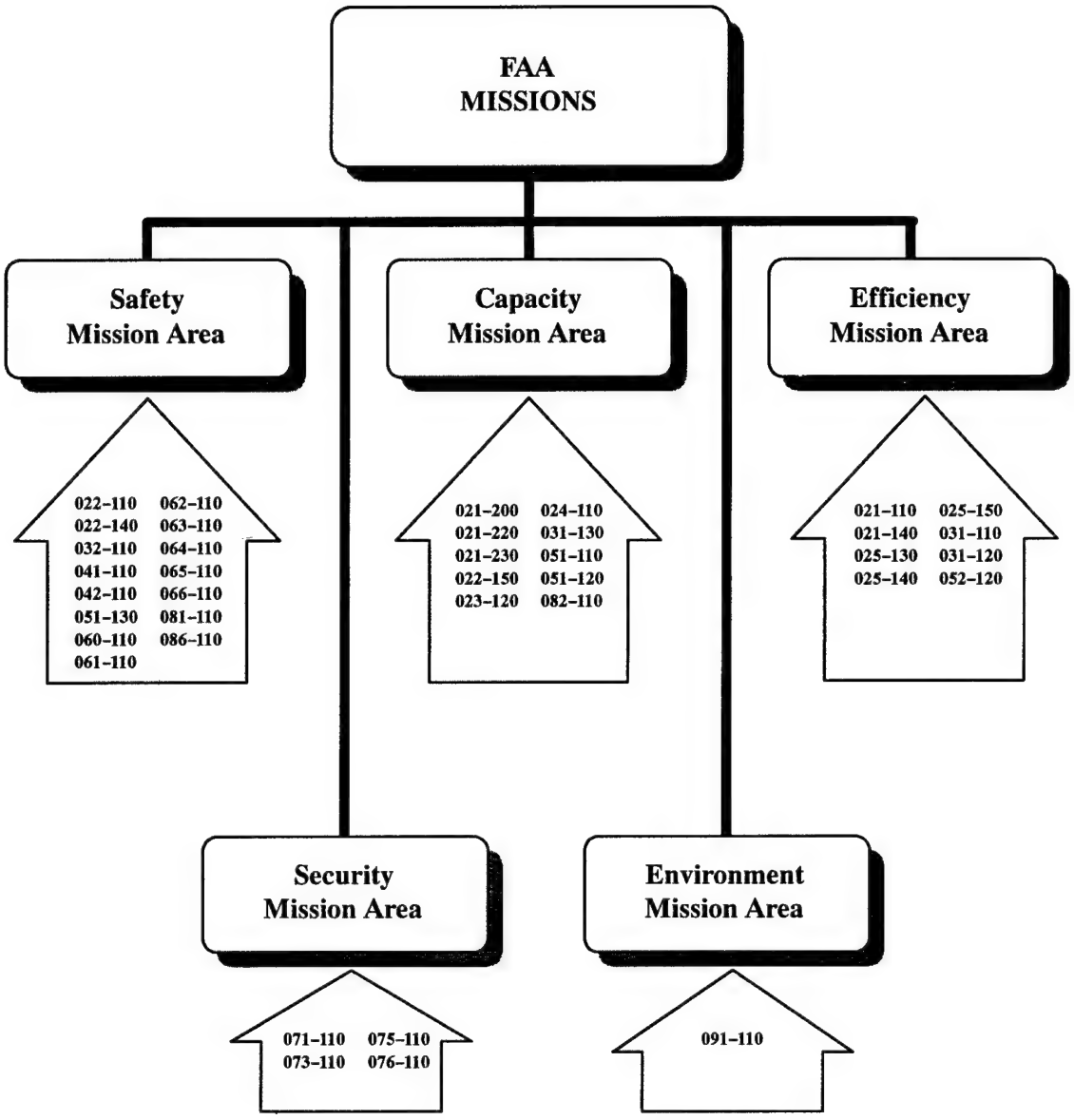


Figure 1–2. Mission Area Contributions

Aviation's Impact on the U.S. Economy

The tourism and travel industry is the world's largest business and is still growing. One trade group predicts that gross output will double over the next decade, adding an estimated 130 million new jobs and another three and one–half trillion dollars to the global economy. Airlines are at the core of this business.

Today, aviation and its value–added components contribute about six percent to the U.S. gross domestic product. In the aggregate, aviation supports more than eight million jobs, earns more than 200 billion dollars annually, and generates about 700 billion dollars of economic activity. Additionally, aviation contributes strongly to the

export side of the U.S. balance of trade. Aviation exporters and travel and tourism generate more than a 20 billion dollar trade surplus each year.

Aviation, far from being an industry settling into stolid maturity, is more dynamic than it has ever been. Like a new business just beginning to gain momentum, aviation is confronted with problems of managing rapid growth and changing market conditions. And like a venture still in its aggressive, entrepreneurial stage, aviation is looking to technology to help cope with these changes. The FAA must be as quick as business to adapt to rapid growth and swiftly changing market conditions.

Challenges for the National Airspace System

The FAA manages and operates a significant national resource, the National Airspace System (NAS). The NAS is the network of U.S. airspace, air traffic equipment and control facilities, services, airports, information, regulations, procedures, and personnel. The demands on the system are continuously growing. This growth requires early identification of issues and technological opportunities related to the safe separation of aircraft, and also affects every other aspect of the NAS.

Traffic Demand

Current economic forecasts indicate continued moderate to strong growth in the demand for aviation services between now and 2007. Aviation activity is forecast to increase by 19.2 percent at the combined FAA and contract–towered airports and 26.6 percent at air route traffic control centers. (See Figure 1–3). In this figure, the activity low point in 1995 was due to a decline in the active general aviation fleet coupled with a decline in the total number of active general aviation pilots. However, the general aviation active fleet is forecast to increase by almost five percent during the forecast period while general aviation hours flown are forecast to grow by almost 10 percent. (See Figure 1–4). Domestic air carrier revenue passenger miles (RPM's) are forecast to increase at an annual rate of 3.8 percent between 1996 and 2007. International air carrier RPM's and passenger enplanements are both forecast to increase at annual rates of 5.3 percent over the 12–year forecast period. (See Figure 1–5). Regional/commuter airline RPM's are expected to increase by 6.7 percent annually over the forecast period, growing from 11.4 billion in 1995 to 24.7 billion in 2007.

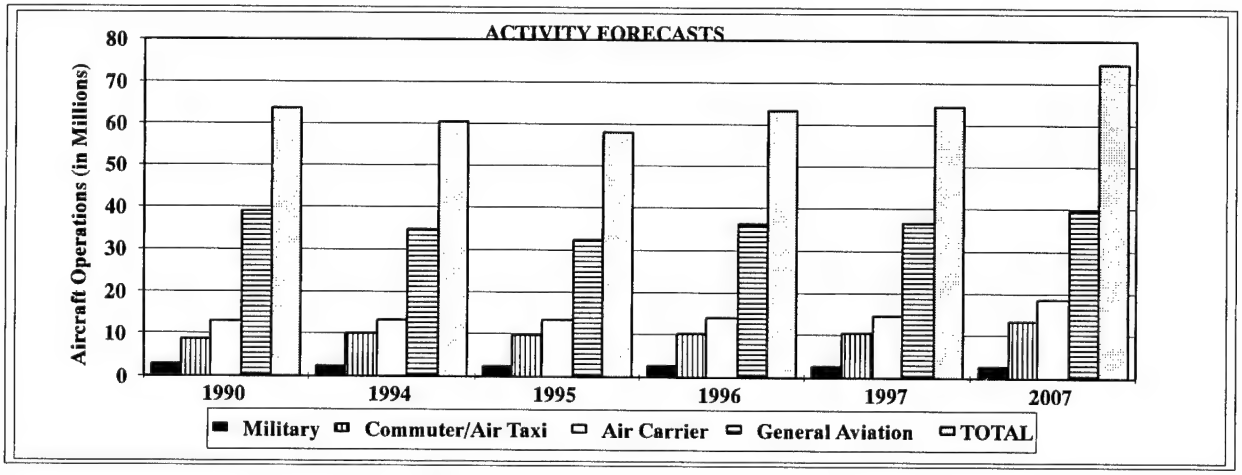


Figure 1–3. Activity Forecasts

(Source: FAA Aviation Forecasts: Fiscal Years 1996–2007, March 1996, pp. 1–13, 14)

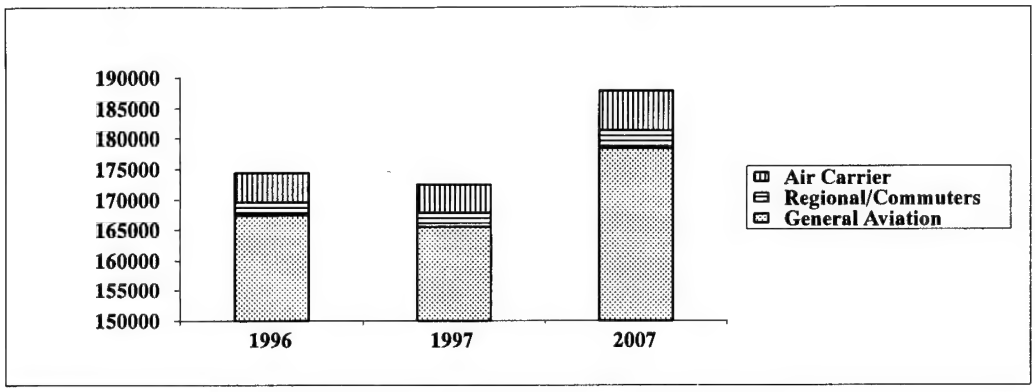


Figure 1–4. Total Civil Aviation Fleet

(Source: FAA Aviation Forecasts: Fiscal Years 1996–2007, March 1996, p. 10)

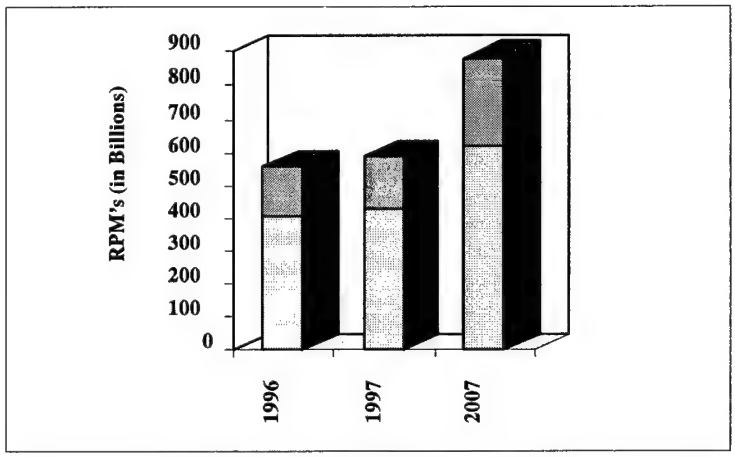


Figure 1–5. Aviation Activity

(Source: FAA Aviation Forecasts: Fiscal Years 1996–2007, March 1996, p. 10)

Security

Aviation security continues to be a challenge. United States airports receive from 200 to 500 bomb threats each year, and U.S. aircraft or foreign aircraft in the United States receive about an equal number. Due to the United States' leadership role in international forums, U.S. civil aviation fleets represent attractive targets to potential terrorists. Continued success in countering these terrorist threats will require vigilance, cooperative effort, and resources. Oklahoma City, the World Trade Center, and the Amtrak derailment show what determined terrorists and criminals can do in this country.

Safety

Over the past 20 years, the aircraft accident fatality rate has been nearly level at just under two deaths per 10 million passengers carried. This statistic is a tribute to aircraft safety provided by the designers, operators, and regulators. Because the civil fleet's size increased over this period, the leveling fatality rate translates into an increase in total fatalities. These statistics indicate that new safety problems have been arising as old ones have been eliminated. Further, some safety problems such as fire and crashworthiness have continued to persist. Reaching the FAA's goal, complete elimination of accidents and incidents from the NAS, will require a major emphasis on safety. (See Figure 1–6).

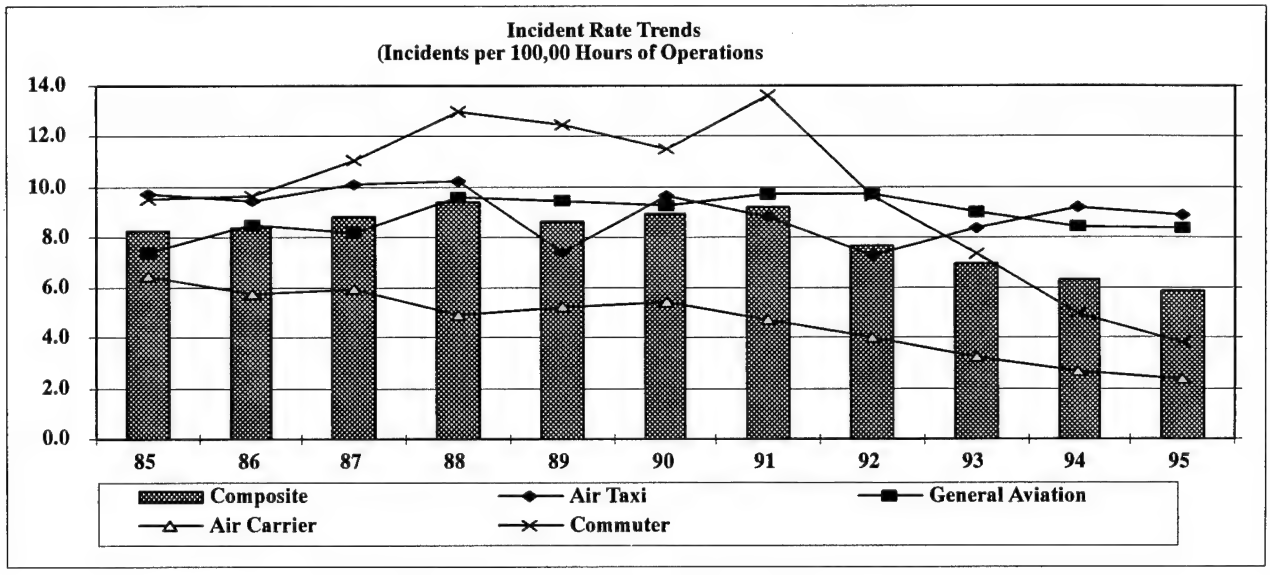


Figure 1–6. Incident Rate Trends

(Source: FAA Annual Report, 1995)

Energy and Environment

Aviation and related industries are also challenged by factors involving energy and the environment. Fuel costs have consistently decreased during recent years, however, they still represent an appreciable percentage of operating cost. While reducing fuel usage is a priority in terms of energy conservation, it is also an increasingly critical environmental issue, based on recent findings relating to nitrogen oxide emissions at high altitudes. Given the projected increases in aviation activity and stringent environmental standards being proposed in Europe and elsewhere, noise and engine emissions reductions are essential to the national aviation industry's viability.

Optimizing Available Resources

Budget constraints are challenging both the FAA and industry. In this environment, it is essential that partnerships be formed to ensure that changes made to the system are beneficial to both. A more efficient NAS incorporating concepts such as free flight, coupled with FAA's increased capability to handle greater traffic loads, will result in both lower user and FAA costs. Free flight, a safe and efficient flight operating capability under instrument flight rules in which the operators have the freedom to select their path and speed in real time, grants both maximum flexibility and guaranteed safe separation to each user. The goal is not only to "optimize" the system but to open the system for each user to "self optimize." Free flight is not limited to airspace, but reaches into a flight's pre–history by providing increased flexibility in flight planning.

The FAA must accommodate the increasing demand on limited airport and airspace capacity, deal with crucial airport security issues, and address safety concerns through all phases of flight to ensure that the NAS continues to be the world's safest airspace. These requirements pose unprecedented challenges, which can only be met through a major investment in R,E&D.

With respect to the use of resources available to support R&D, two indicators are used in the private sector to determine how various industries compare in terms of their investment in R&D. One of these indicators is expressed as the percent that R&D funding is of total yearly sales. The other indicator is expressed as the number of

dollars spent on R&D per employee. In a recent study of 900 large U.S. companies engaged in significant R&D, there were 18 distinct groupings of industries whose interests ranged from aerospace and defense to paper and paper products. The indicators for these industries ranged from 10.6 percent of sales and $18,247 per employee for the health care industry to 0.8 percent of sales and $1,391 per employee for the food industry.

The study formed a composite industry to represent the 18 industries that accounted for the 900 large companies. Indicators for the composite industry for R&D effort were 3.8 percent of sales and $7,476 per employee. Using total appropriations for the FAA as a substitute for annual sales, the indicators for FAA R,E&D were 2.9 percent of yearly appropriations and $4,900 per FAA employee. (See Figure 1–7 and Figure 1–8). Among the 18 industries studied it was found that the telecommunications industry was most similar to the FAA in terms of the kinds of operations performed, the operation of large–scale networks and various dispersed facilities, and the kinds and number of employees required. The indicators for the telecommunications industry were 3.7 percent of sales and $7,149 per employee and compare favorably with the values for the composite industry. In terms of resources used to support R&D, indicators for FAA R,E&D were less than indicators for either the composite industry or the telecommunications industry.

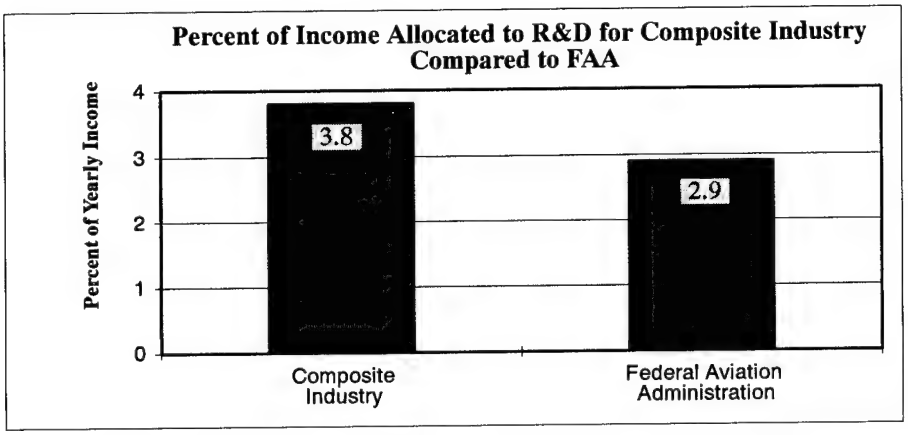


Figure 1–7. Percent of Income Allocated to R&D

(Data Source: "R&D Scoreboard," Business Week/June 27, 1994, pg. 78)

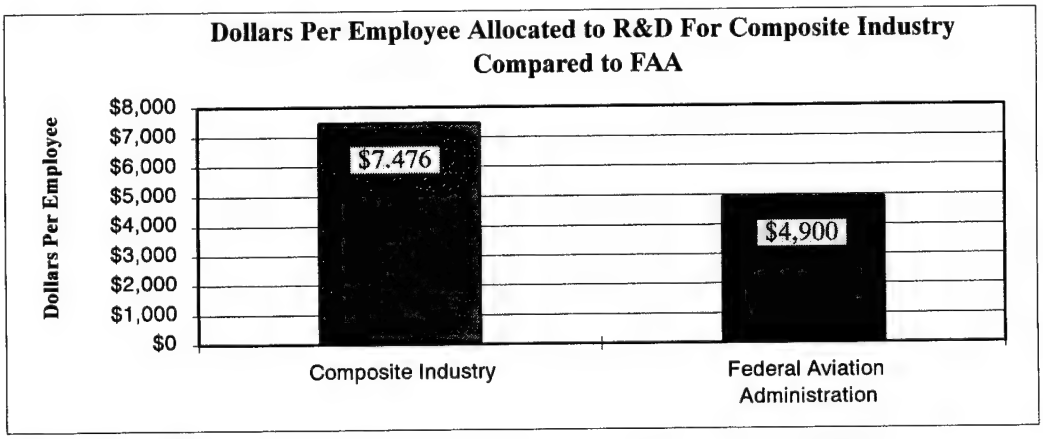


Figure 1–8. Dollars Per Employee Allocated to R&D

(Data Source: "R&D Scoreboard," Business Week/June 27, 1994, pg. 78)

The FAA Research, Engineering, and Development Management Reform Act of 1996 directed the FAA to identify the allocation of resources among long–term research, near–term research, and development activities.

Long–term research, as defined in the Aviation Safety Research Act of 1988, is a research project "...which is unlikely to result in a final rulemaking action within 5 years, or in the initial installation of operational equipment within 10 years, after the data of the commencement of such project." In accordance with congressional direction, not less than 15 percent of amounts appropriated is to be allocated for long–term research projects. Figure 1–9 shows that 17 percent of the FAA's Research, Engineering and Development (R,E&D) appropriation is currently allocated for long–term research projects.

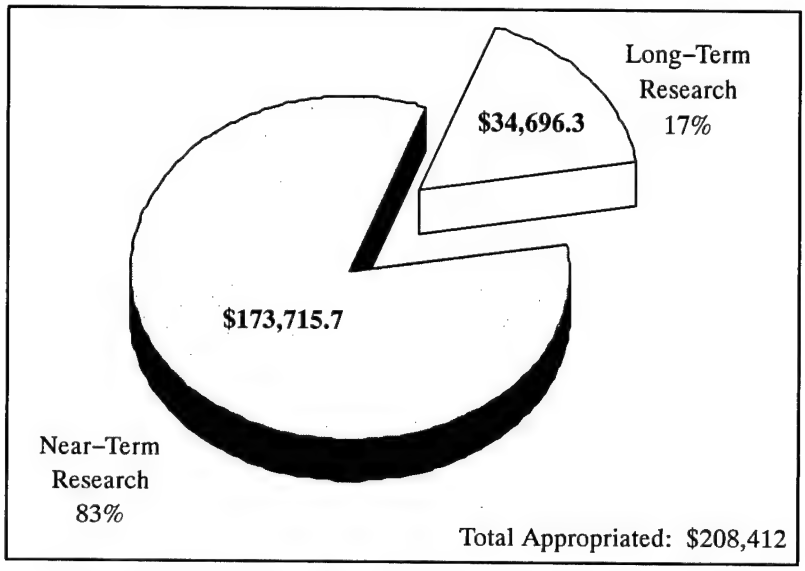


Figure 1–9. Fiscal Year 1997 Long–Term Research

The FAA's R,E&D appropriation is principally associated with applied research. More developmental activities beyond this stage, such as prototype or full scale development, can be found in the Engineering, Development, Test, and Evaluation activity of the FAA's Facilities and Equipment (F&E) appropriation.

1.2 The R,E&D Program

Research, Engineering and Development Portfolio Planning Process

The research efforts represented by the programs selected for the R,E&D portfolio address key issues and problems currently affecting the National Airspace System. A summary description of these driving forces can be found in "Challenges for the National Airspace System" in Section 1.1. A detailed description of these key issues and problems is located in the introduction to each thrust area in Chapters 2, 3, 4, 5, 6, 7, 8, and 9.

Historical R,E&D Portfolio Analysis

Historical analysis of the R,E&D portfolio of projects shows that although the yearly appropriations for the FAA R,E&D program have been variable, the fractions of the yearly appropriations when categorized by the FAA mission areas of safety, security, capacity, environment, and efficiency, have remained relatively

constant. When R&D support program costs (about $13–$15 million) are not considered, R,E&D appropriations per year vary in mission emphasis on a yearly basis, as shown in Figure 1–10. Appropriations increased from about $190 million in FY 1992 to about $244 million in FY 1995. This rising trend changed abruptly when the appropriations decreased to about $174 million in FY 1996.

Figure 1–10 also shows that, for FY 1997 the appropriation is below the appropriations level for the previous years. The budget for FY 1998 will provide about $200 million for total FAA R,E&D. Again, the appropriations levels depicted in Figure 1–10 do not include funding levels for the R,E&D support programs described in Appendix A and Appendix B of this Plan.

Analysis of Figure 1–10 shows that historically the safety mission area has consistently received the largest funding amount for each of the years in the 7–year period, even as the yearly appropriations varied from one year to the next. At the same time, the environment mission area consistently received the smallest amount of funding, while the capacity, security, and efficiency mission areas received the second largest funding amounts.

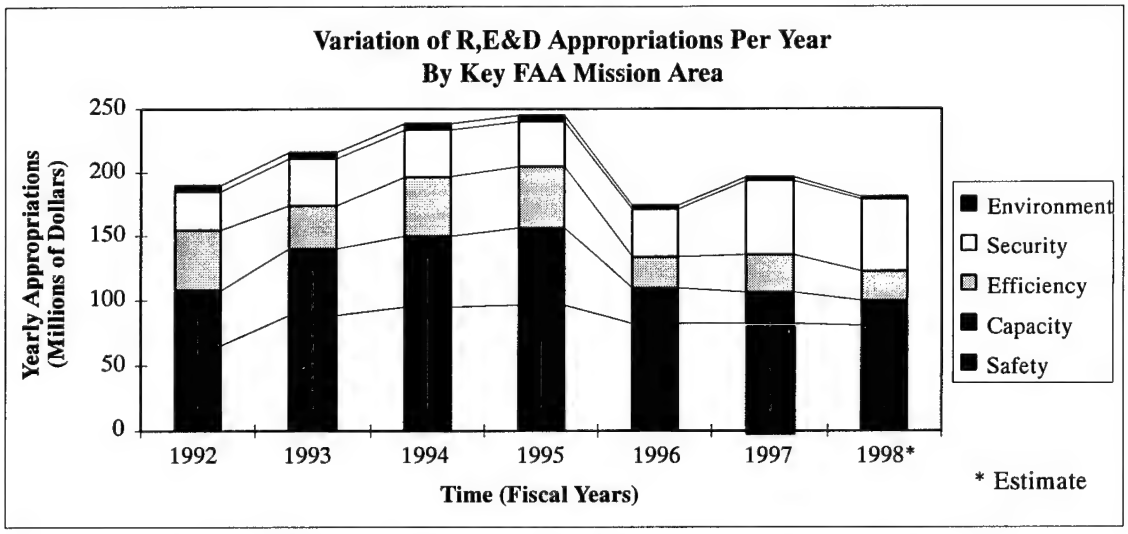


Figure 1–10. Variation of R,E&D Appropriations Per Year

Figure 1–11, R,E&D Yearly Appropriations By Mission Area, shows that of the FAA's key mission areas, safety, security, capacity, environment, and efficiency, three of them, taken jointly, have accounted for 77 percent to 83 percent of the total R,E&D appropriations received during the period FY 1992 to FY 1998, inclusive. The safety mission area accounted for 35 percent to 50 percent of the total R,E&D appropriation; capacity accounted for 13 percent to 24 percent of the total, and efficiency accounted for 14 percent to 24 percent of the total.

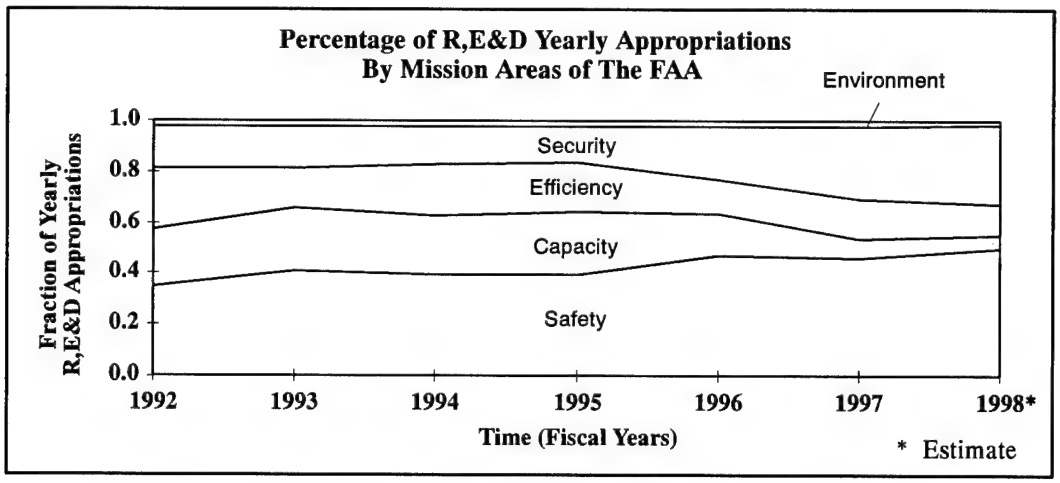


Figure 1–11. R,E&D Yearly Appropriations by Mission Area

The Portfolio Development Process

In establishing its R,E&D program portfolio, the FAA uses an extensive evaluation process. Unless specifically mandated by Congress or committed to by the Administrator in terms of specific funding levels, there are no protected projects. In developing the R,E&D budget, each individual program is evaluated on elements determined to be important to the FAA's mission. These elements include: benefits for airspace users; contribution to the FAA Strategic Plan goals and objectives; consistency with the NAS architecture; technological relevance to the FAA's mission; risk; and consistency with facilities and equipment (F&E) planning. Figure 1–12 depicts the R,E&D portfolio development process.

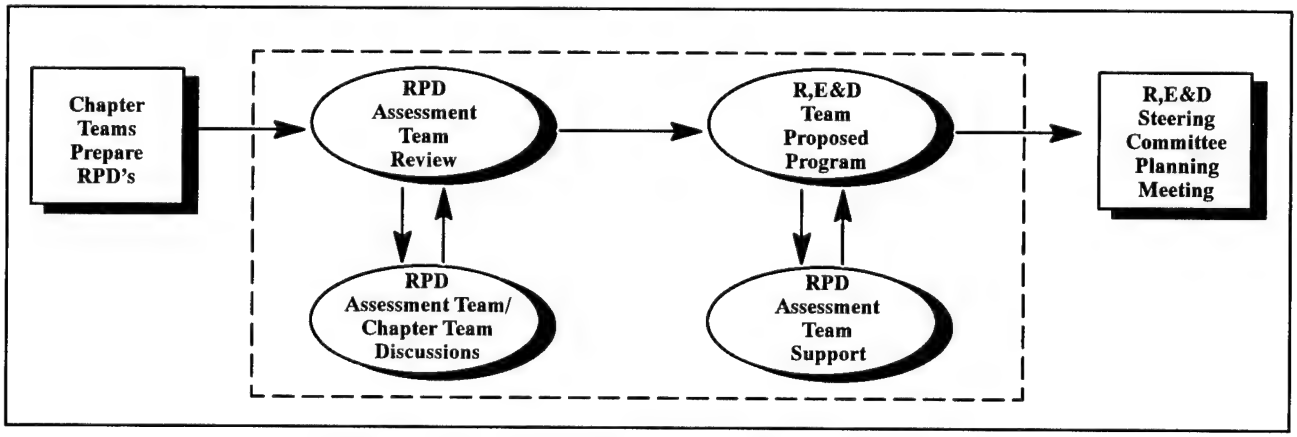


Figure 1–12. R,E&D Program Selection Process

During the initial stage of the R,E&D program selection process, sponsors and program representatives develop a comprehensive research project description (RPD) designed to provide the following standardized information on each project:

- What are the major products of the R,E,&D program?
- When will these products be delivered?
- What are the ultimate benefits to the users and/or the FAA?

- What must the aviation community, including the FAA, invest to achieve those benefits?

To provide a rational framework for assessing individual research projects and for selecting a set of projects for inclusion in the R,E&D Plan, the RPD's are evaluated using a mathematical tool called an "appropriateness index." This index is comprised of two parts: (1) a measure of the expected benefits of a successful research project and (2) a measure of the alignment of the research project with FAA needs and capabilities.

Ranking by the appropriateness index is only a starting point for establishing the final prioritization of R,E&D programs. Other considerations are:

- Balance across FAA mission areas
- Balance between near–term benefits and long–term research
- Balance between risk, benefits, and cost
- Affordability – the ratio of the first year cost to the 5–year cost of the research project, showing the future financial burden of research under consideration (Figure 1–13)
- Program/project dependencies and linkages

Results of the prioritization process are forwarded to the R,E&D Steering Committee for final portfolio selection. Figure 1–14 represents the distribution of funds across mission areas for the submission of the budget.

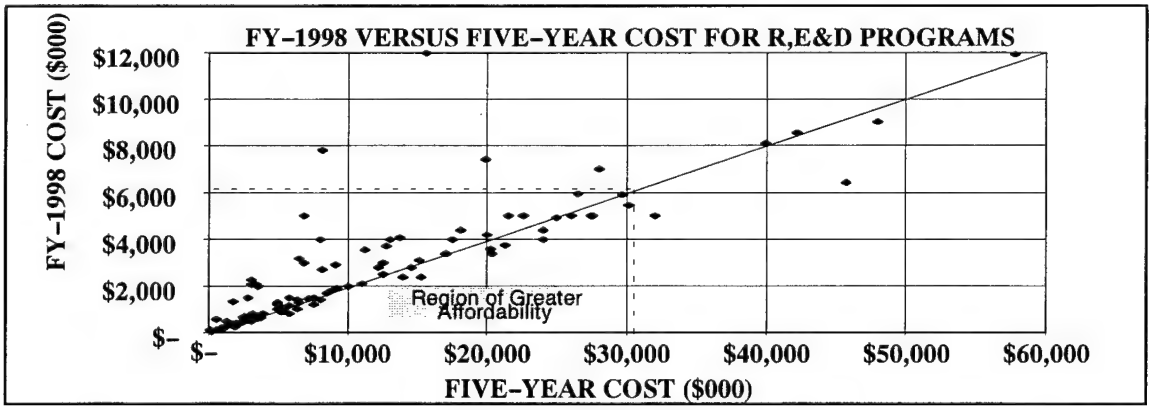


Figure 1–13. Affordability – FY 1998 vs. Five–Year Cost for R,E&D Programs

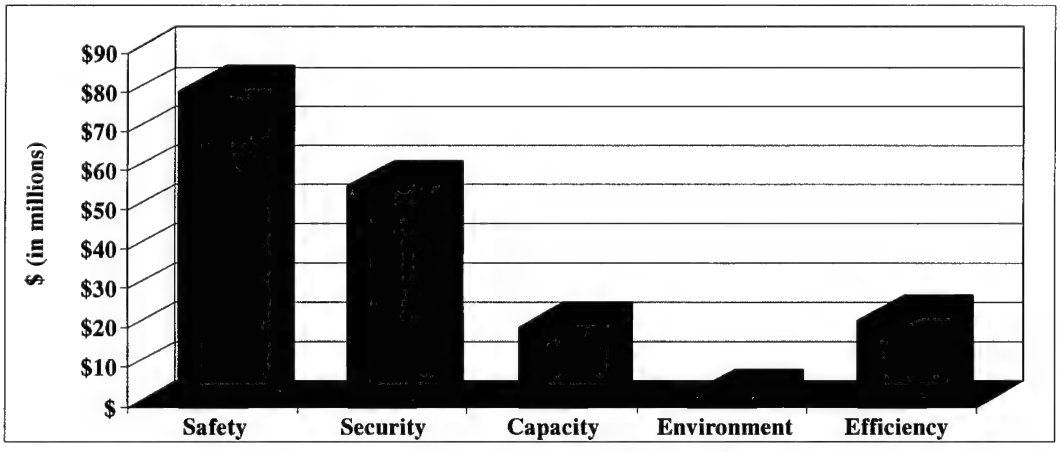


Figure 1–14. Investment By Mission Area

The R,E&D Advisory Committee

The FAA strongly involves the R,E&D Advisory Committee in reviewing the FAA R,E&D program, and the FAA pays close attention to all Committee recommendations.

During fiscal year 1996, the R,E&D Advisory Committee submitted recommendations to the FAA in six reports. Of the six reports, the FAA currently is reviewing four reports including: the *Final Report of the Aviation Weather Subcommittee*; the *Report of the Challenge 2000 Subcommittee*; the *Report to the Committee on the Status and Organization of Human Factors Within the FAA*; and the *Aviation Security Research and Development Report*. FAA plans to respond to these reports between January and April of 1997. FAA has responded to the remaining two reports: the *Review of the FAA Research and Development Investments* and the *Review of the Aircraft Safety Research Programs*. The following sections provide the Committee's recommendations and the FAA's responses to these two reports. FAA agrees with all of the Committee recommendations in these two reports and has implemented or is working to implement the recommendations.

Recommendations and Responses From the June 5–6, 1996 R,E&D Advisory Committee Meeting

The Committee met to review the FAA's proposed research and development investment portfolio for fiscal year 1998. The Committee formed three groups to accomplish the review, one addressing regulatory projects, one addressing air traffic services projects and one that reviewed the entire program.

Recommendations by the group addressing regulatory projects:

- FAA should establish standing subcommittees to review R,E&D chapters (program areas) to assure customer buy–in on an ongoing basis.
  - Response: FAA proposes to establish these subcommittees at the January 1997 R,E&D Advisory Committee meeting. Standing subcommittees will be established for air traffic services, airport technology, aircraft safety, aviation security, human factors and environment and energy.

- FAA should establish a subcommittee to examine leveraging opportunities with industry, other government agencies and the international community.
  - Response: FAA plans for the standing subcommittees to accomplish this.

- FAA should convene a "summit" with industry to solicit cooperation in research and development (R&D).
  - Response: FAA plans for the standing subcommittees to propose specific plans and an approach to accomplish this.

- FAA should enhance cost–benefit analysis to assist prioritization of R,E&D investments.
  - Response: FAA is working with the Volpe National Transportation Systems Center of DOT to strengthen its cost–benefit analysis capability as it applies to prioritization of R,E&D investments.

Recommendations by the group addressing air traffic services projects:

- FAA should provide a top–level overview of the program when communicating with the Committee.
  - Response: FAA agrees and will provide this top–down perspective in future discussions with the Committee.

- FAA should not "salami slice" the program to fit the available budgets. ("Salami slicing"

refers to a practice of reducing the funding of all programs by the same percentage in response to R,E&D program budget cuts as opposed to eliminating some programs and fully funding others.)

- Response: FAA agrees that "salami slicing" is an ineffective technique for program management and does not endorse the practice.

- FAA should consider establishing a research fund with users, for example, the airlines.
  - Response: FAA will refer this suggestions to the standing subcommittee on air traffic services.

- FAA should not fund the AF infrastructure project with R,E&D dollars, but should use Facilities and Equipment (F&E) or Operations funding.
  - Response: FAA is considering this recommendation and will respond to the Committee in January 1997.

- FAA should provide a higher priority for the weather program, and question the mountain–induced hazards project.
  - Response: FAA is considering this recommendation and will respond to the Committee in January 1997.

Recommendations by the group addressing the entire program:

- FAA should form a subcommittee to focus on the end–to–end certification process, including commercial–off–the–shelf (COTS) products.
  - Response: FAA is considering this recommendation and will respond to the Committee at the January 1997 Advisory Committee meeting.

- FAA should establish a decision support database providing cost–benefit data for R,E&D investment analysis.
  - Response: FAA is working with the Volpe National Transportation Systems Center of DOT to improve its cost–benefit analysis capabilities.

- FAA should expedite the definition of the system architecture.
  - Response: FAA is expediting the development of the system architecture. The status of the architecture development effort will be described at the January 1997 Advisory Committee meeting.

- FAA should emphasize the development of operational concepts for meeting future user requirements for air traffic management (ATM) services.
  - Response: FAA has recently established an office for this purpose in its system architecture organization.

- FAA should provide a higher priority for the weather program.
  - Response: This recommendation is under consideration by FAA. FAA will refer this issue to the Air Traffic Services Subcommittee for further development.

- FAA should accelerate research on the Global Positioning System (GPS) Local Area Augmentation System (LAAS).
  - Response: LAAS is a high priority within the FY 1998 R,E&D program.

- Is FAA giving aircraft safety and security too high a priority in the budget?
  - Response: FAA is re–examining these priorities in completing the FY 1998

R,E&D budget submission and will respond to the Committee in January 1997.

- FAA should leverage aircraft safety and security investments better with industry.
  - Response: FAA will refer this issue to the Aircraft Safety and Aviation Security Subcommittees so that they can propose specific plans and an approach.

- Should FAA place more emphasis on safety and security issues associated with system software?
  - Response: FAA will refer this issue to the standing subcommittee on air traffic services so they can propose specific plans and an approach.

Recommendations and Responses to the Aircraft Safety Report (February 14, 1996)

Five teams met with personnel of the FAA Technical Center during the summer of 1995 to review current and planned research, engineering and development in the area of aircraft safety. The five teams are working groups of the Subcommittee on Aircraft Safety and represent the following speciality areas: Transport Aircraft, General Aviation, Rotorcraft, Cabin Safety and Propulsion. The reviews covered Chapter 6 of the R,E&D Plan: "Aircraft Safety Technology."

The subcommittee recommended reduced emphasis in four areas:

- Corrosion
  - Response: FAA agrees. FAA will reduce funding levels to zero by FY 1998.

- Very Large Commercial Transport (VLCT) Fire Safety
  - Response: FAA agrees. The only activity in this area that FAA will pursue is technical monitoring of industry plans and programs.

- Catastrophic Failure Prevention
  - Response: FAA has moved the project down in priority and refocused it based on working group recommendations. FAA also reduced funding for the project by reallocating funding.

- Advanced Materials
  - Response: FAA reduced funding in FY 1996 significantly but plans funding increases in the future for activities focused on regulatory needs and industry trends based on the working group's recommendations.

The subcommittee recommended increased emphasis in six areas:

- Structural Response
  - Response: FAA has raised the program to the number 1 priority in aircraft safety and increased the funding level in FY 1996 and FY 1997.

- Electromagnetics Test & Analysis
  - Response: FAA has provided some increase in funding.

- Standard Smoke Detector Test Criteria
  - Response: In FY 1997, FAA plans to increase emphasis and funding in this area.

- Fuselage Structural Fire Safety
  - Response: FAA has provided some increase in funding.

- Cabin Safety Risk Analysis
  - Response: Congress zero funded this initiative in the aircraft safety technology program area. Some work in cabin safety

is continuing in the aeromedical program area at the Civil Aeromedical Institute (CAMI) in collaboration with Cranfield Institute (UK).

- Passenger Evacuation
  - Response: Congress zero funded this initiative in the aircraft safety technology program area. Some work in passenger evacuation is continuing at a low level in the aeromedical program area at CAMI in collaboration with Cranfield Institute (UK).

The FAA values the Committee's advice and guidance which represents diverse viewpoints from the user community and from experts in relevant technology areas.

Other R,E&D Program Relationships

Cooperative Research With NASA and DOD

The FAA, in an effort to ensure maximum leveraging of research funds and to eliminate duplicative activities, cooperates extensively with both the National Aeronautics and Space Administration and the Department of Defense.

In November 1993, the President established the National Science and Technology Council (NSTC) to assess federal research and development priorities and to better integrate research and development efforts across agencies. An NSTC committee on transportation published the report, Goals for a National Partnership in Aeronautics Research and Technology, focusing on needs and benefits associated with federal research and development investments in aeronautics and aviation. In response to this report, an Aeronautics and Aviation Subcommittee, chaired jointly by the FAA Associate Administrator for Research and Acquisitions, the NASA Associate Administrator for Aeronautics, and the DOD Director of Advanced Technology, was formed to develop a strategic view of federal research and development investments. The subcommittee's report will be used by the Office of Management and Budget to review future budget submissions to ensure coordination among the three organizations.

Formal coordination between the FAA and NASA has been an ongoing activity through the FAA/NASA Coordinating Committee. The committee is jointly chaired by the FAA Associate Administrator for Research and Acquisitions and the NASA Associate Administrator for Aeronautics. The committee established formal memoranda of understanding defining broad research areas of mutual interest in human factors, airworthiness, severe weather, environmental compatibility, and integration of cockpit and air traffic control operations.

In 1995, the FAA and NASA signed a memorandum of understanding that initiates joint research and development activities to develop, validate, and implement airspace system user operational flexibility and productivity improvements. The initiative will be managed by a FAA/NASA Integrated Product Team. The team will address both near– and long–term requirements, with initial emphasis on improvements that can be implemented within the next ten years.

Cooperative interagency research agreements between the FAA and DOD span a broad spectrum of research areas including: Security – detecting explosives in carry–on and checked baggage and cargo; Safety – nondestructive inspection techniques; and Human Factors – situational awareness and decisionmaking processes for controllers and aircrews and research in flight crew fatigue and other physiological factors affecting performance and efficiency.

In the future, the FAA will continue to investigate avenues for leveraging scarce research resources through additional partnerships with other

government agencies, industry, and foreign aviation research and development organizations.

Dissemination of Research Results to the Private Sector

Throughout 1996, FAA continued its strong support of new technology in partnerships with private industry. FAA and industry jointly developed new materials and manufacturing processes for a "soft ground arresting system". Numerous aircraft have run off the end of a runway when problems arose during takeoff or landing. The overruns have resulted in injured passengers and damaged aircraft. FAA and industry jointly developed a new concrete foam material which will safely slow and finally halt a large airliner. In a demonstration at the FAA's William J. Hughes Technical Center, a Boeing 727 aircraft accelerated to 50 knots then drove onto the new soft ground arresting system. The concrete foam safely stopped the 727 within 50 feet. The manufacturing firm now has a contract to install the system at major New York area airports (LaGuardia, JFK and Newark).

Through the national Technology Reinvestment Project (TRP), FAA is participating in $303 million in new research and development projects with industry. FAA is currently working with more than 80 industry partners on 15 major technology development projects. Some of the earlier projects have now developed products. In one particularly important project, FAA has partnered with Rosemount Aerospace, Inc., McDonnell Douglas Corporation and Northwest Airlines to develop an ice detection system for aircraft wings. Wing ice is a dangerous condition which has caused numerous fatalities in both large and small aircraft. This new state–of–the–art system sends an ultrasonic signal along metal plates on the aircraft wings to a signal processing unit inside the aircraft. The signal processor analyzes changes to determine if ice, water or residual deicing fluid are on the wing. This information will be sent immediately to the cockpit for the pilot's use.

In the areas of fire safety and airport security, FAA continues to maintain a strong partnership in the development of new technology with industry throughout the nation. Fires are a major threat to all aircraft. In addition to the fire blocking seat underlayers mandatory on all passenger aircraft, FAA is working with industry on the development of new insulation materials which not only refuse to burn but also block the progress of an outside fuel fire. The precious minutes provided by these materials will give passengers added time to safely evacuate the aircraft. Since foreign aircraft manufacturers routinely purchase FAA certified or FAA approved components for their aircraft, development of these advanced fire–resistant materials creates new products for U.S. export.

Relationship With the FAA NAS Architecture

The NAS architecture is intended to provide a comprehensive plan for an evolutionary modernization of the National Airspace System that will deliver incremental benefits to both NAS users and service providers. The initial version of the NAS architecture outlined the basic concepts and principles of the NAS architecture and established the direction and method for the architecture's further development. As this development continues, the architecture will rapidly bring benefit to the process of infrastructure investment by providing analytically defensible rationale for investment decisions. When the architecture is mature, it will be the principal framework of NAS infrastructure investment decisions.

Far–term and mid–term architecture alternatives are likely to require applications of technology that are not yet well understood. The FAA will conduct analyses to understand application risks, benefits, and costs of new technology. New

R,E&D capabilities will be developed where needs are identified.

R,E&D support for the NAS architecture falls under two of the seven primary services areas, Air Traffic Services and NAS Infrastructure Services. In addition, for R,E&D, a third service category is added to account for non–ATC services.

Air Traffic Services is divided into subareas NAS Air Traffic Operations and NAS Air Traffic Information. NAS Air Traffic Operations and NAS Air Traffic Information services are those involving performance of an action or provision of an information product that directly enables or enhances flight operations by commercial, general, and military aviation. A flight operation begins and ends with aircraft movement on an airport surface. Services of flight are external in that they are provided to NAS users. The third auxiliary service, Non–ATC Services, includes R,E&D Support and Regulatory Services.

The categories comprising NAS Air Traffic Operations and NAS Air Traffic Information include:

- Separation – services to aircrews in flight, primarily directive in nature, that provide information required for safe clearance from other aircraft, weather and terrain. They may be provided routinely or upon request.

- Flight Planning – services provided both prior to and during flight that are required by aircrews in planning a safe and orderly flight.

- Advisory – services to aircrews, primarily in flight, that provide information contributing to safe and orderly flight but that are non–directive in nature.

- NAS Capacity and Demand Management – services intended to optimize utilization of airspace and airport surfaces for the benefit of users in general or to enable users to make informed decisions about their own operations.

- Guidance – services to aircrews that primarily assist in determining an aircraft's position, either in fixed geographic coordinates, or in relationship to a landing or takeoff position.

- Flight Assistance and Monitoring – services to aircrews, aircraft operations, and government authorities, primarily upon request, to aid in activities such as search and rescue or military operations.

- Data and Communications Management – services that primarily are enablers of the information flow required to provide services of flight.

NAS Infrastructure services are those services involving control, operation, evaluation, maintenance, and accounting for all equipment, systems and structures that facilitate the movement of aircraft within the national airspace. These services are separate from and parallel to the Air Traffic services.

The category comprising NAS Infrastructure Services includes:

- Infrastructure Management – services that provide a sustaining capability for the systems and equipment that comprise the NAS infrastructure.

Like the architecture itself, the architectural service areas continue to evolve. Once the service areas are mature and finalized, R,E&D support for the service areas will also be revised to more effectively characterize the R,E&D interrelationship with architecture.

Research efforts in R,E&D programs support architectural services as well as mission areas. Figure 1–15 shows the projected distribution of funding for FY 1998 across the applicable service areas.

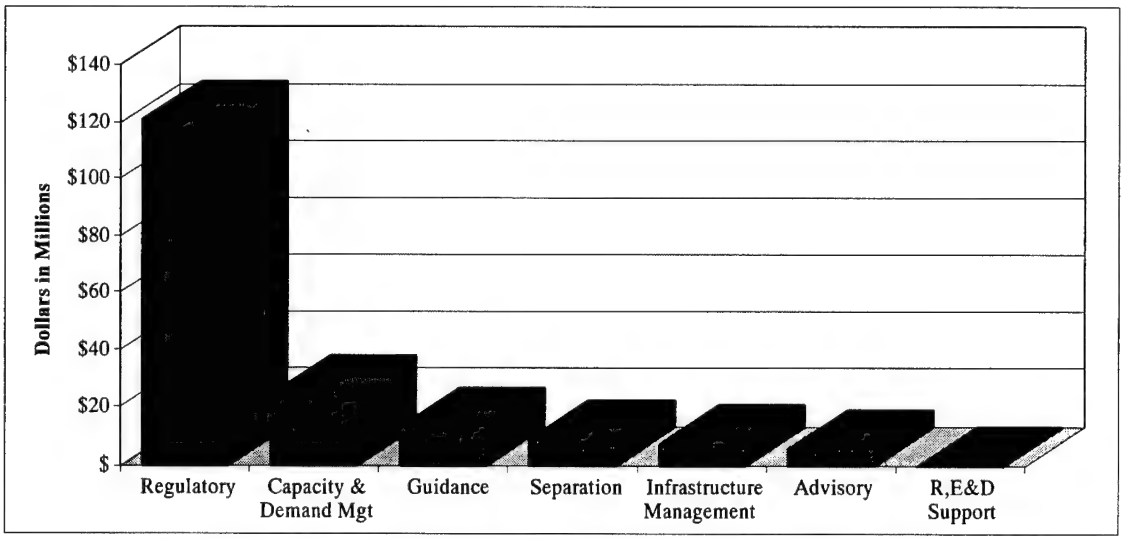


Figure 1–15. Investment By Architectural Service Areas

Table 1–1 shows projected funding changes from FY 1996 to FY 1998 at the junction between FAA mission areas and architectural service areas. In three of these junction areas funding is projected to increase over the period, and in 10 junction areas funding may decrease. In the junctions between safety/regulatory, security/regulatory, and efficiency/infrastructure management, funding is not projected to change appreciably, that is funding remains within ±4%. These trends show that the R,E&D portfolio mix adjusts, and will continue to adjust, to support both the needs of the evolving NAS architecture and the FAA's missions.

Table 1–1. Funding for Mission Area/Architectural Service Area

A Comparison of R,E&D Appropriations for FY 1996 and Planned FY 1998					
	FAA Mission Areas				
	Safety	Security	Capacity	Efficiency	Environment
Regulatory	●	⬤	⬤		○
Guidance	⬤			○	
Separation	○		○	○	
Advisory	○				
Data & Communications Management			○		
Capacity & Demand Management			○	⬤	
R,E&D Support				○	
Infrastructure Management			○	●	
⬤ Indicates Increase		○ Indicates Decrease		● Indicates No Change	

Figure 1–16 depicts the set of R,E&D programs that contribute to applicable architectural service areas. Programs are listed by budget reference number. For a description of these programs, see chapters 2 through 9.

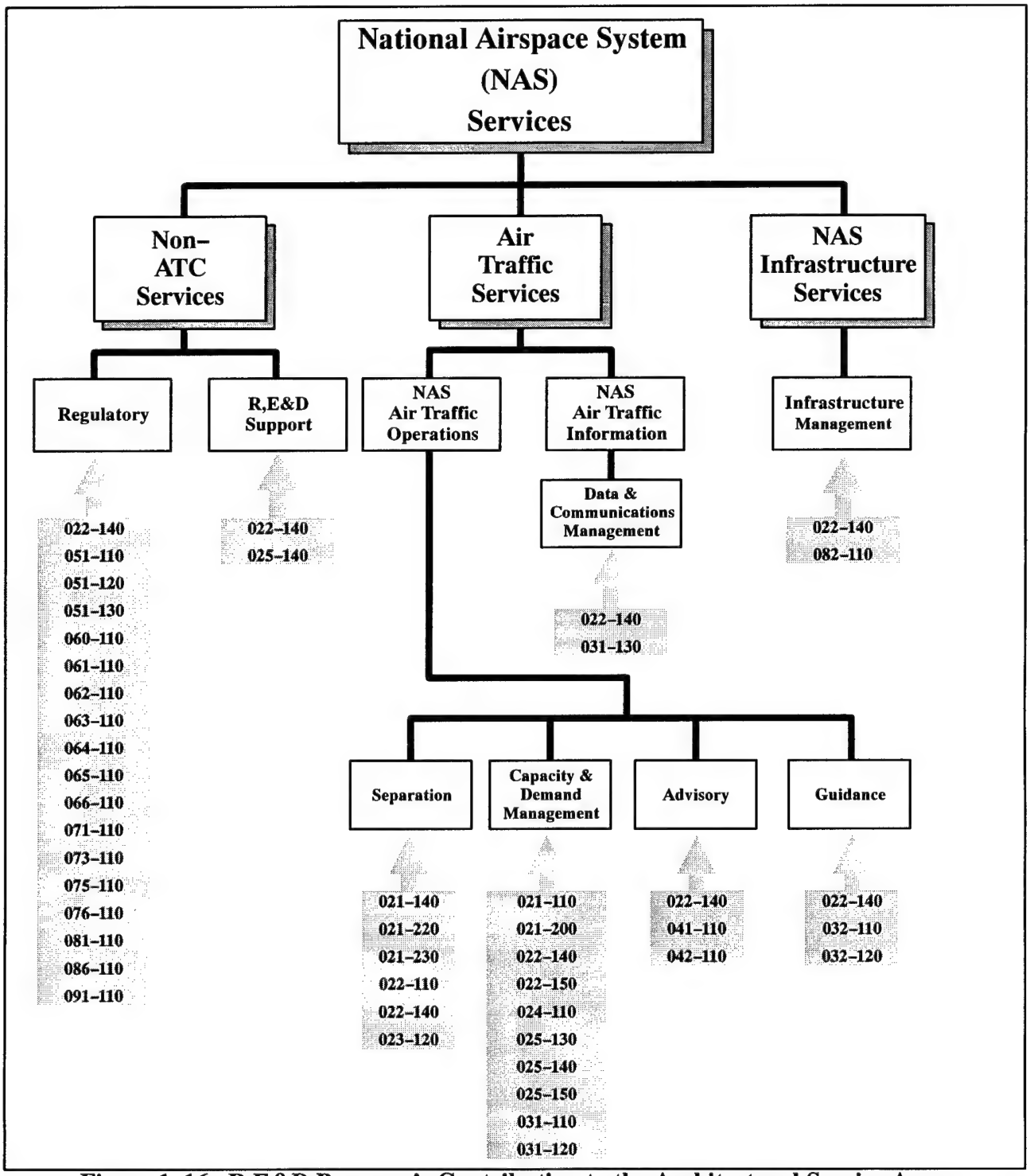


Figure 1–16. R,E&D Program's Contribution to the Architectural Service Areas

Relationship With the Capital Investment Plan

Programs within the R,E&D Plan work in conjunction with facilities and equipment (F&E) programs in the Capital Investment Plan to serve as the FAA's implementation pipeline. Several R,E&D programs develop the new technology systems required for the FAA to meet its mission in the 21st century. After prototype systems have proven to be operationally beneficial and technologically low risk, the responsibility for acquisition moves to the F&E programs in the CIP. R,E&D programs also provide the research data, tools, and analyses to support standards, procedures, and design guidelines used by selected F&E programs to revise and verify efforts in progress. The following table, Table 1–2, depicts some of the major contributions R,E&D programs provide to F&E programs.

Table 1–2. R,E&D Program Contributions to F&E Programs (Sheet 1 of 3)

R,E&D Program Name and Number	CIP Program Name and Number and R,E&D Contribution
021–110 Advanced Traffic Management System (ATMS)	A–05 Traffic Management System (TMS) ▪ ATMS provides the software upgrades and enhancements to the operational TMS.
021–140 Oceanic Air Traffic Automation	A–10 Oceanic Automation Program (OAP) ▪ Oceanic Air Traffic Automation provides the prototypes, requirements definition, studies and analyses to OAP. The R,E&D and CIP oceanic program work is accomplished as an integrated program.
021–200 Surface Movement Advisor (SMA)	A–02 Tower Automation Program ▪ SMA may be incorporated into or be an independent augmentation to the tower A–05 Traffic Management System (TMS) ▪ SMA will provide a source of surface data. A–12 Airport Surface Target Identification System (ATIDS) ▪ SMA will increase protective zone from incursion around runways.
021–220 Multiple Runway Procedures Development	A–05 Traffic Management System (TMS) ▪ Multiple Runway Procedures Development will provide multiple runway procedures for adaptation of center TRACON automation system. S–08 Precision Runway Monitor (PRM) ▪ Multiple Runway Procedures Development provides feedback on PRM site–specific requirements and researches and develops procedures for doing instrument approaches to multiple, parallel runways.
021–230 Wake–Vortex Separation Standards	A–05 Traffic Management System (TMS) ▪ Wake Vortex–Separation Standards provides an automation tool which provides the adaptive air separation in the terminal area.
022–110 Traffic Alert and Collision Avoidance System	S–02 Mode S ▪ TCAS provides surveillance avionics interoperability monitoring.
022–150 Flight Operations and Air Traffic Management Integration	A–05 Traffic Management System (TMS) and A–12 Airport Surface Target Identification System (ATIDS) ▪ Flight Operations and Air Traffic Management integration is slated as a preplanned product improvement for AERA, TMS, CTAS, and SMA.
023–120 Separation Standards	A–10 Oceanic Automation Program (OAP) ▪ Separation standards provides data to support standards that may require engineering specification changes to fielded equipment.
025–130 Air Traffic Models and Evaluation Tools	A–05 Traffic Management System (TMS) ▪ Air Traffic Models and Evaluation Tools provides the aircraft situation display composite Z data.

Table 1–2. R,E&D Program Contributions to F&E Programs (Sheet 2 of 3)

R,E&D Program Name and Number	CIP Program Name and Number and R,E&D Contribution
031–110 Aeronautical Data Link Communications and Applications	A–04 Standard Terminal Automation Replacement System (STARS) ▪ Provides the data link specifications, MOPs, SARPs, and the IRD and provides the results of the research on data link applications and communications to include the terminal area. A–12 Airport Surface Target Identification System (ATIDS) ▪ Aeronautical Data Link Communications and Applications provides the operational concepts for development of ADS–B that will be used by ATIDS. C–20 Aeronautical Data Link ▪ Aeronautical Data Link Communications and Applications provides all of the research and development for implementation of the operational data link systems. R,E&D and F&E data link work is accomplished as an integrated program. W–03 Terminal Doppler Weather Radar (TDWR) System ▪ Aeronautical Data Link Communications and Applications is developing the early capability for terminal weather information for pilots and deploying prototypes at all TDWR sites. W–07 Integrated Terminal Weather System (ITWS) ▪ Aeronautical Data Link Communications and Applications is developing the early capability for terminal weather information for pilots that will be transitioned in ITWS.
031–120 Satellite Communications Program	A–10 Oceanic Automation Program (OAP) ▪ Satellite Communications Program is developing the concepts for using SATCOM as a subnetwork for the aeronautical telecommunications network (ATN) in the oceanic environment. C–20 Aeronautical Data Link ▪ Satellite Communications Program is developing the concepts for using SATCOM as a subnetwork for the ATN.
031–130 NAS Telecommunications for the 21st Century	C–20 Aeronautical Data Link ▪ NAS Telecommunications for the 21st Century provides the data to support VHF radio standards for the new generation of VHF radios which also include data link functions. C–21 Next Generation Air/Ground Communications System ▪ NAS Telecommunications for the 21st Century provides the data to support VHF radio standards that are being used to develop the new generation of VHF radios W–07 Integrated Terminal Weather System (ITWS) ▪ NAS Telecommunications for the 21st Century provides open system interfaces telecommunications standards for use in developing ITWS.
032–110 Satellite Navigation Program	A–01 En Route Automation Program ▪ Satellite Navigation Program GPS augmentation research will provide the positional accuracy necessary for future non–radar surveillance functions in the en route and terminal areas. A–02 Tower Automation Program ▪ Satellite Navigation Program provides the research for local area augmentation system (LAAS)/wide area augmentation system (WAAS) development. LAAS will provide positive navigation for aircraft replacing ground–based navigation systems for Category II/III approaches and LAAS status may need to be displayed on the tower control computer complex. A–04 Standard Terminal Automation Replacement System (STARS) ▪ The GPS research program is investigating the possibilities for non–radar surveillance in the terminal area. A–10 Oceanic Automation Program (OAP) ▪ Satellite Navigation Program automatic dependent surveillance will use GPS for positioning data. This research supports receiver autonomous integrity monitoring procedures.

Table 1–2. R,E&D Program Contributions to F&E Programs (Sheet 3 of 3)

R,E&D Program Name and Number	CIP Program Name and Number and R,E&D Contribution
032–110 Satellite Navigation Program (continued)	C–21 Next Generation Air/Ground Communications System ▪ Satellite Navigation Program GPS augmentation research into time transfer will provide the data necessary to use GPS as a timing source for time division multiple access radios. N–03 Instrument Landing System ▪ Satellite Navigation Program provides the research for LAAS/WAAS development which will determine when GPS can be implemented to replace ground–based systems. The future Category II/III decommissioning schedule needs to be coordinated with GPS implementation. N–12 Augmentations for the Global Positioning System (GPS) ▪ Satellite Navigation Program develops the required navigation performance and transition strategy for LAAS/WAAS augmentation of GPS. The finalized RNP requirements may affect options for reference stations and geosynchronized satellites exercised under the WAAS contract.
032–120 Navigation Systems Architecture	N–03 Instrument Landing System; N–06 VORTAC; M–09 Sustain Distance Measuring Equipment (DME); N–10 Sustain Nondirectional Beacon (NDB); and N–12 Augmentations for the Global Positioning System (GPS) ▪ Develops the required navigation performance and and transition strategy for LAAS/WAAS augmentation of GPS. The finalized RNP requirements may affect options for reference stations and geosynchronized satellites exercised under the WAAS contract.
041–110 Aviation Weather Analysis and Forecasting	W–04 Weather and Radar Processor (WARP) ▪ Aviation Weather Analysis and Forecasting provides expertise for the review of design specifications for WARP as well as develops the capability for the National Weather Service products that WARP will process and display. W–07 Integrated Terminal Weather System (ITWS) ▪ Aviation Weather Analysis and Forecasting provides the algorithms, specifications and research used to produce terminal weather products to be used by ITWS.
051–130 Airport Safety Technology	N–04 Visual Navaids ▪ Provides research data and requirements for alternative approach lighting systems.
060–110 Aviation Safety Risk Analysis	A–18 Safety Performance Analysis System (SPAS) ▪ The Aging Aircraft project is conducting research to develop algorithms, models, and future improvements that will be implemented through SPAS. Also developing and testing the infrastructure for SPAS.
065–110 Aging Aircraft	A–15 Civil Aviation Registry Modernization ▪ The Aging Aircraft program will provides additional data on aircraft registration to the registry that is not presently included. A–17 Aviation Safety Analysis System (ASAS) ▪ Analysis performed on data element functions as a quality control check for the ASAS information. A–20 Integrated Flight Quality Assurance ▪ Provides feedback on usefulness of data. Aging aircraft recorders enhance capability to acquire flight operations quality assurance data. M–18 Computer Resources Nucleus (CORN) ▪ Aging Aircraft provides requirements for data to be used in the developing and testing of aging aircraft information analytical models.

Relationship With FAA Strategic Plan

The FAA Strategic Plan sets out the agency's goals and objectives and provides outcome–based, corporate performance measures for evaluating progress toward meeting the goals. The Strategic Plan focuses on 95 proposed major accomplishments over the next 5 years. The annual Business Performance Plans for the FAA's lines of business contain more specific, program–based performance measures that indicate the near–term contributions each FAA line of business will make to longer range Strategic Plan goals and objectives. The result for the FAA is strategic management, guided by a strategic plan, implemented in decentralized business performance plans that combine strategic change with the need to support ongoing operations.

Goals and objectives in the FAA Strategic Plan focus on the following areas of concern: System Safety, Security, and Human Factors; System Capacity; Global Leadership; Environmental Responsibility; FAA Business Practices; Transforming FAA into the Model Federal Workplace; and Communication.

Table 1–3 lists the R,E&D programs supporting applicable strategic goals and objectives in the FAA Strategic Plan.

Table 1–3. R,E&D Programs Supporting FAA Strategic Goals and Objectives
(Sheet 1 of 10)

SYSTEM SAFETY, SECURITY, AND HUMAN FACTORS	
Goal 1:	**System Safety — Zero Accidents. Eliminate accidents and incidents in aviation and protect public safety and property in space transportation systems by targeting the most critical areas.**
Objective 1A.	**Strengthen safety risk assessment and risk management throughout the FAA by developing and implementing an agency wide policy supported by guidance, training, data resources, analytical tools, and other resources.**
060–110	Aviation Safety Risk Analysis – *Automation and decision support system for risk assessments by safety inspectors and certification engineers*
062–110	Advanced Materials/Structural Safety – *Data to support certification standards, performance specifications, and advisory circulars on crashworthiness and structural safety of advanced materials aircraft*
063–110	Propulsion and Fuel Systems – *Criteria, guidelines, and data for turbine and piston engine certification requirements as new fuels and materials are employed in next generation aircraft*
064–110	Flight Safety/Atmospheric Hazards – *Technical data to support regulatory and certification processes associated with new digital technology and natural and manmade atmospheric hazards*
065–110	Aging Aircraft – *Means for evaluating and ensuring safety and reducing the risk associated with aging aircraft structures*
066–110	Aircraft Catastrophic Failure Prevention Research – *Methods to identify, reduce, and prevent aircraft system problems that could result in catastrophic aircraft failure*

Table 1–3. R,E&D Programs Supporting FAA Strategic Goals and Objectives (Sheet 2 of 10)

086–110	Aeromedical Research – *Recommendations and development of protective equipment or procedures and guidance for FAA regulatory and medical certification staff*
Objective 1B.	**Improve the effectiveness of FAA safety inspection resources through risk assessment and operational indicators.**
060–110	Aviation Safety Risk Analysis – *Automation and decision support system for risk assessments by safety inspectors and certification engineers*
Objective 1C.	**Address key safety issues, including aging aircraft hazards, the safety of aircraft movement on the airport surface, and weather.**
021–200	Surface Movement Advisor (SMA) – *Enhanced surface safety system*
021–230	Wake–vortex Separation Standards – *Safely reducing separation standards through wake vortex research*
022–110	Traffic Alert and Collision Avoidance System (TCAS) – *An independent airborne collision avoidance capability*
022–140	General Aviation and Vertical Flight Program – *Introduction and expansion of technology into the NAS for general aviation (conventional and advanced design) fixed and rotary wing aircraft*
032–110	Satellite Navigation Program – *Standards and methods to use satellite navigation signals to meet civil aviation requirements*
041–110	Aviation Weather Analysis and Forecasting – *Improved weather information, forecasts, and observations*
042–110	Aeronautical Hazards Research – *Improved capability to detect, monitor, and alert flight crews to mountain–induced turbulence*
051–110	Airport Planning and Design Technology – *Design standards and advisory information for runways, taxiways, aprons, gates, airports, terminals, and ground access systems*
051–130	Airport Safety Technology – *New technologies in runway surfaces, visual guidance systems, airport rescue and firefighting, and wildlife control in the airport environment*
061–110	Aircraft Systems Fire Safety – *Near–term design improvements to increase fire safety in in–flight and post–crash fires*
062–110	Advanced Materials/Structural Safety – *Data to support certification standards, performance specifications, and advisory circulars on crashworthiness and structural safety of advanced materials aircraft*
063–110	Propulsion and Fuel Systems – *Criteria, guidelines, and data for turbine and piston engine certification requirements as new fuels and materials are employed in next generation aircraft*

Table 1–3. R,E&D Programs Supporting FAA Strategic Goals and Objectives (Sheet 3 of 10)

064–110	Flight Safety/Atmospheric Hazards – *Technical data to support regulatory and certification processes associated with new digital technology and natural and manmade atmospheric hazards*
065–110	Aging Aircraft – *Means for evaluating and ensuring safety and reducing the risk associated with aging aircraft structures*
066–110	Aircraft Catastrophic Failure Prevention Research – *Methods to identify, reduce, and prevent aircraft system problems that could result in catastrophic aircraft failure*
081–110	Flight Deck, Maintenance, Flight Deck/ATC, System Integration Human Factors – *Improve pilot, aircraft maintenance, and inspection personnel performance and reduce the adverse effects of flightcrew, maintenance, and inspection errors through improved system design, procedures, and training*
086–110	Aeromedical Research – *Recommendations and development of protective equipment or procedures and guidance for FAA regulatory and medical certification staff*
Objective 1D.	**Improve FAA oversight of industry performance based on shared use of safety–related data and development of trend indicators. Address the problem of data confidentiality in order to improve FAA oversight.**
060–110	Aviation Safety Risk Analysis – *Automation and decision support system for risk assessments by safety inspectors and certification engineers*
Objective 1G.	**Provide the same level of safety to all passengers traveling on regularly scheduled commercial air craft with more than nine seats.**
022–110	Traffic Alert and Collision Avoidance System (TCAS) – *An independent airborne collision avoidance capability*
062–110	Advanced Materials/Structural Safety – *Data to support certification standards, performance specifications, and advisory circulars on crashworthiness and structural safety of advanced materials aircraft*
064–110	Flight Safety/Atmospheric Hazards – *Technical data to support regulatory and certification processes associated with new digital technology and natural and manmade atmospheric hazards*
065–110	Aging Aircraft – *Means for evaluating and ensuring safety and reducing the risk associated with aging aircraft structures*
Goal 2: Security — Zero Incidents. Eliminate security incidents in the aviation system.	
Objective 2A.	**In consultation with airports and airlines, address specific vulnerabilities in the U.S. aviation system identified through risk assessment and data analysis.**
071–110	Explosive/Weapons Detection – *Improved systems and operational procedures to detect explosives/weapons on passengers, baggage, cargo, and mail*

Table 1–3. R,E&D Programs Supporting FAA Strategic Goals and Objectives (Sheet 4 of 10)

073–110	Airport Security Technology Integration – *New security technology and procedures integrated into airport operational environments*
075–110	Aircraft Hardening – *Methods to increase aircraft survivability by reducing the effects of explosives and other terrorist actions on commercial aircraft*
076–110	Aviation Security Human Factors – *Methods to maximize human performance within the aviation security system*
Objective 2B.	**Strengthen the baseline of security through better selection and training of screeners and other security personnel, improve procedures, and accelerate development and application by industry of new technologies.**
071–110	Explosive/Weapons Detection – *Improved systems and operational procedures to detect explosives/weapons on passengers, baggage, cargo, and mail*
073–110	Airport Security Technology Integration – *New security technology and procedures integrated into airport operational environments*
075–110	Aircraft Hardening – *Methods to increase aircraft survivability by reducing the effects of explosives and other terrorist actions on commercial aircraft*
076–110	Aviation Security Human Factors – *Methods to maximize human performance within the aviation security system*
Objective 2C.	**Reduce the risk of security incidents in international civil aviation by working with foreign governments and international bodies to address vulnerabilities and strengthen each country's baseline of security.**
071–110	Explosive/Weapons Detection – *Improved systems and operational procedures to detect explosives/weapons on passengers, baggage, cargo, and mail*
Goal 3: Human Factors – Zero Accidents. Eliminate human factors as a causal factor in accidents and incidents.	
Objective 3A.	**Resolve the most critical equipment–related, design–induced human performance degradations in certification, regulation, and FAA acquisitions.**
076–110	Aviation Security Human Factors – *Methods to maximize human performance within the aviation security system*
081–110	Flight Deck, Maintenance, Flight Deck/ATC, System Integration Human Factors – *Improve pilot, aircraft maintenance, and inspection personnel performance and reduce the adverse effects of flightcrew, maintenance, and inspection errors through improved system design, procedures, and training*
082–110	Air Traffic Services Human Factors – *Scientifically validated information that focuses on improving the performance and productivity of the human operator in the Air Traffic and Airway Facilities organizations*

Table 1–3. R,E&D Programs Supporting FAA Strategic Goals and Objectives (Sheet 5 of 10)

086–110	Aeromedical Research – *Recommendations and development of protective equipment or procedures and guidance for FAA regulatory and medical certification staff*
Objective 3B.	**Correct the most critical training-related contributions to error by NAS operations and maintenance personnel.**
065–110	Aging Aircraft – *Means for evaluating and ensuring safety and reducing the risk associated with aging aircraft structures*
076–110	Aviation Security Human Factors – *Methods to maximize human performance within the aviation security system*
081–110	Flight Deck, Maintenance, Flight Deck/ATC, System Integration Human Factors – *Improve pilot, aircraft maintenance, and inspection personnel performance and reduce the adverse effects of flightcrew, maintenance, and inspection errors through improved system design, procedures, and training*
082–110	Air Traffic Services Human Factors – *Scientifically validated information that focuses on improving the performance and productivity of the human operator in the Air Traffic and Airway Facilities organizations*
Objective 3C.	**Design procedures that enhance human performance in the most critical areas for NAS operations and maintainers.**
076–110	Aviation Security Human Factors – *Methods to maximize human performance within the aviation security system*
081–110	Flight Deck, Maintenance, Flight Deck/ATC, System Integration Human Factors – *Improve pilot, aircraft maintenance, and inspection personnel performance and reduce the adverse effects of flightcrew, maintenance, and inspection errors through improved system design, procedures, and training.*
082–110	Air Traffic Services Human Factors – *Scientifically validated information that focuses on improving the performance and productivity of the human operator in the Air Traffic and Airway Facilities organizations.*
086–110	Aeromedical Research – *Recommendations and development of protective equipment or procedures and guidance for FAA regulatory and medical certification staff*

Table 1–3. R,E&D Programs Supporting FAA Strategic Goals and Objectives (Sheet 6 of 10)

SYSTEM CAPACITY

Goal 4: Meet the system capacity needs for air and space transportation safely and efficiently through near–term actions targeted at specific problems and a long–term comprehensive program of research, planning, and investment matching user needs.

Objective 4A. System Capacity Measurement — Develop and implement standards of success — national capacity indicators — that will be used to highlight system capacity requirements and prioritize investments in capacity and delay–reduction solutions to user needs.

024–110 Aviation System Capacity Planning
- *Recommended procedures, equipment, and physical facilities for terminal airspace that will increase capacity*

Objective 4B. Near Term Initiatives — Implement technological and procedural improvements in the air traffic control system to reduce the impact of near–term airspace and airport capacity constraints.

021–110 Advanced Traffic Management System (ATMS)
- *Collaborative decisionmaking and decision support tools to allow traffic flow managers to work cooperatively with industry to respond to NAS congestion conditions*

021–200 Surface Movement Advisor (SMA)
- *Enhanced surface safety system*

021–220 Multiple Runway Procedures Development
- *Air traffic control procedures to reduce airport delays by more fully using multiple–runway capacity during instrument meteorological conditions*

021–230 Wake–vortex Separation Standards
- *Safely reducing separation standards through wake vortex research*

022–110 Traffic Alert and Collision Avoidance System (TCAS)
- *An independent airborne collision avoidance capability*

022–150 Flight Operations and Air Traffic Management Integration
- *Capability to integrate flight management computer operations with ground–based air traffic management automation*

023–120 Separation Standards
- *Quantitative guidance for domestic and international efforts to establish minimum vertical and horizontal separation standards*

025–130 Air Traffic Models and Evaluation Tools
- *Modeling and analytic tools to support operational improvements*

025–150 Free Flight Implementation
- *Provide a coordinated agency research, engineering, and development response to proposals for changes in operational concepts, particularly free flight*

082–110 Air Traffic Services Human Factors
- *Scientifically validated information that focuses on improving the performance and productivity of the human operator in the Air Traffic and Airway Facilities organizations*

Table 1–3. R,E&D Programs Supporting FAA Strategic Goals and Objectives (Sheet 7 of 10)

Objective 4C.	**National Airspace System (NAS) Infrastructure — maintain and modernize the NAS infrastructure to meet current and future demands for air traffic control and air transportation needs.**
031–110	Aeronautical Data Link Communications and Applications – *Enhanced air traffic management communications capabilities*
032–110	Satellite Navigation Program – *Standards and methods to use satellite navigation signals to meet civil aviation requirements*
032–120	Navigation Systems Architecture – *The strategy for transitioning to satellite technology*
051–120	Airport Pavement Technology – *Standards for pavement design, evaluation, materials, construction, and repairs*
Objective 4D.	**Oceanic — Change, in concert with the international aviation community, oceanic air traffic control from its current control environment to one with capabilities similar to the future domestic control environment.**
021–140	Oceanic Air Traffic Automation – *Enhanced automation capabilities to increase oceanic air traffic capacity and efficiency*
023–120	Separation Standards – *Quantitative guidance for domestic and international efforts to establish minimum vertical and horizontal separation standards*
031–120	Satellite Communications Programs – *Standards and testing to support mobile satellite communication operational use for civil aviation*
Objective 4E.	**Weather Forecasting, Detection, and Dissemination -- Reduce the impact of weather phenomena on system capacity by improved weather forecast and increased accuracy, resolution, and dissemination of observations on the ground and in the air.**
041–110	Aviation Weather Analysis and Forecasting – *Improved weather information, forecasts, and observations*
042–110	Aeronautical Hazards Research – *Improved capability to detect, monitor, and alert flight crews to mountain-induced turbulence*
Objective 4F.	**Communications, Navigation, and Surveillance — Implement communication, navigation, and surveillance (CNS) and satellite navigation capabilities through an aggressive industry/government partnership that achieves user benefits in all phases of aviation and space transportation operations at the earliest possible time.**
031–120	Satellite Communications Programs – *Standards and testing to support mobile satellite communication operational use for civil aviation*
031–130	NAS Telecommunications for the 21st Century – *Improved air/ground and ground/ground communications systems*

Table 1–3. R,E&D Programs Supporting FAA Strategic Goals and Objectives (Sheet 8 of 10)

032–110	Satellite Navigation Program – *Standards and methods to use satellite navigation signals to meet civil aviation requirements*
032–120	Navigation Systems Architecture – *The strategy for transitioning to satellite technology*
Objective 4H.	**Congested Airports — Establish an FAA-led airport system planning process, in concert with the aviation community, focused on severely congested airports, to anticipate the demand for air transportation, identify the consequences in terms of congestion, and evaluate alternative solutions.**
024–110	Aviation System Capacity Planning – *Recommended procedures, equipment, and physical facilities for terminal airspace that will increase capacity*
Objective 4I.	**Airport Capacity Enhancements — Ensure the timely implementation of high priority airport system capacity enhancements through planning, grants, application of sound investment criteria, and innovative financing.**
051–110	Airport Planning and Design Technology – *Design standards and advisory information for runways, taxiways, aprons, gates, airports, terminals, and ground access systems*
Objective 4K.	**Airport Research Program — Conduct a research program to develop airport planning procedures and design guidance for high capacity airfields, terminals, and ground access systems.**
051–110	Airport Planning and Design Technology – *Design standards and advisory information for runways, taxiways, aprons, gates, airports, terminals, and ground access systems*
051–120	Airport Pavement Technology – *Standards for pavement design, evaluation, materials, construction, and repairs*
051–130	Airport Safety Technology – *New technologies in runway surfaces, visual guidance systems, airport rescue and firefighting, and wildlife control in the airport environment*
	GLOBAL LEADERSHIP
Goal 6:	**Achieve safe, secure, and efficient global air and space transportation systems by promoting international cooperation and harmonization.**
Objective 6A.	**Provide world leadership by promoting international harmonization through cooperative efforts to align certification, operational, and maintenance standards, practices, and procedures, and by collaborating with the international community on policy, operational, and environmental initiatives.**
031–110	Aeronautical Data Link Communications and Applications – *Enhanced air traffic management communications capabilities*
032–110	Satellite Navigation Program – *Standards and methods to use satellite navigation signals to meet civil aviation requirements*

Table 1–3. R,E&D Programs Supporting FAA Strategic Goals and Objectives (Sheet 9 of 10)

061–110	Aircraft Systems Fire Safety – *Near–term design improvements to increase fire safety in in–flight and post–crash fires*
Objective 6C.	**Provide technical assistance and training to enhance international aviation safety and security.**
061–110	Aircraft Systems Fire Safety – *Near–term design improvements to increase fire safety in in–flight and post–crash fires*
062–110	Advanced Materials/Structural Safety – *Data to support certification standards, performance specifications, and advisory circulars on crashworthiness and structural safety of advanced materials aircraft*
065–110	Aging Aircraft – *Means for evaluating and ensuring safety and reducing the risk associated with aging aircraft structures*
Objective 6D.	**Contribute to the efforts of the International Civil Aviation Organization (ICAO) to become more efficient and responsive to the needs of its members in today's dynamic technological environment and ensure that the interest of the United States government are well represented within the organization.**
031–110	Aeronautical Data Link Communications and Applications – *Enhanced air traffic management communications capabilities*
031–120	Satellite Communications Programs – *Standards and testing to support mobile satellite communication operational use for civil aviation*
	ENVIRONMENTAL RESPONSIBILITY
Goal 7:	**Provide strong leadership regarding the environmental impacts of aviation and commercial space transportation.**
Objective 7B.	**Reduce the impact of aircraft noise by 80 percent (based upon population) by 2000, through an optimal mix of new aircraft certification standards, operational procedures, land use initiatives, and technology.**
091–110	Environment and Energy – *Regulations and tools to control and evaluate the environmental impact of aviation*
Objective 7C.	**Minimize the impact of aircraft emissions through an optimal mix of new aircraft certification standards, operational procedures, and technology.**
063–110	Propulsion and Fuel Systems – *Criteria, guidelines, and data for turbine and piston engine certification requirements as new fuels and materials are employed in next generation aircraft*
091–110	Environment and Energy – *Regulations and tools to control and evaluate the environmental impact of aviation*

Table 1–3. R,E&D Programs Supporting FAA Strategic Goals and Objectives (Sheet 10 of 10)

Objective 7D.	**Assist public use airports in applying practicable measures to avoid or minimize adverse impacts on air, soil, and water quality and comply with federal and state standards relating to these resources.**
063–110	Propulsion and Fuel Systems – *Criteria, guidelines, and data for turbine and piston engine certification requirements as new fuels and materials are employed in next generation aircraft*
091–110	Environment and Energy – *Regulations and tools to control and evaluate the environmental impact of aviation*
Objective 7E.	**Create an environmentally effective and responsive FAA both domestically and internationally.**
091–110	Environment and Energy – *Regulations and tools to control and evaluate the environmental impact of aviation*
	FAA BUSINESS PRACTICES
Goal 8:	**Manage resources and investments to control costs and increase productivity, efficiency, and effectiveness, while promoting safety and customer needs.**
Objective 8B.	**Maximize improvements in mission performance and agency processes through the effective use of information and technology to reduce costs and increase quality service levels.**
025–140	System Performance and Investment Analysis – *Broad objective analysis support for evaluating R,E&D investment options*
	COMMUNICATION
Goal 10:	**Establish and maintain mutual lines of communication with the public and with employees to promote understanding, awareness, and cooperation and to serve the interests of the traveling public.**
Objective 10B.	**Promote two–way communications with FAA's customers and stakeholders, and especially with the flying public, to anticipate emerging needs and communicate effectively the impact of FAA's policy and regulatory decisions.**
022–140	General Aviation and Vertical Flight Program – *Introduction and expansion of technology into the NAS for general aviation (conventional and advanced design) fixed and rotary wing aircraft*

2.0 CAPACITY AND AIR TRAFFIC MANAGEMENT TECHNOLOGY

ATC SYSTEM CAPACITY AND AUTOMATION TECHNOLOGY

A major FAA Research, Engineering and Development (R,E&D) aim is to increase air traffic control (ATC) system capacity. Automating the ATC information gathering process is already advanced, but requires major improvement and augmentation in the supporting technologies. The need to help controllers/system managers cope successfully and efficiently with increasing numbers of more demanding and capable aircraft requires introducing automation aids for conducting the ATC process itself. While in the past it was possible to spread the work among a variety of separable functions (oceanic, en route, terminal, tower/airport, etc.), efficient operations now demand carefully integrating and managing aircraft flows throughout the operating regime without artificial "walls."

Increasingly, the air traffic management (ATM) process and its supporting elements must be considered a single system. In the following material, the term "air traffic control" refers to the tactical safety separation service that prevents collisions between aircraft and between aircraft and obstructions. "Traffic flow management" refers to the process that allocates traffic flows to scarce capacity resources. "Air traffic management" is the composite process ensuring safe, efficient, and expeditious aircraft movement. Air traffic control and traffic flow management are components of the air traffic management process.

Further ATM system development must be evolutionary. There is often the temptation to design on a "clean sheet of paper" to take full advantage of new capabilities that new technology offers. The reality is that transition and integration are the most difficult institutional problems facing system designers. However, while change in the system will be evolutionary, the design for the future is intended to provide a well understood, manageable, cost-effective improvement sequence. These improvements will keep pace with user needs for safety, capacity, efficiency, and environmental demands.

DEVELOPMENT CHALLENGES

The FAA R,E&D efforts needed to achieve increased ATM system capacity and to introduce automation technology represent a major effort with many important challenges to the FAA's and the Nation's R,E&D community. Among the many challenges, the following may stand out in importance:

- To develop a system architecture and create a system design that recognizes and accommodates the full ATM system demands as an integrated whole.
- To establish the appropriate balance between the basic ATC separation processes and the overlying flow management/control system.
- To establish the best ways for controllers/system managers to interact with and effectively use automation systems to handle more variables safely and efficiently.
- To achieve the correct balance between strategic planning, tactical execution, and modifying the ATM as near as possible to the flight

environment. This balance will be accomplished by rapid information exchange from all available sources, and by using alternative plans created by rule-based computers.

- To establish the best tactical responsibility balance between participating flightcrews with increasingly capable aircraft systems and the centralized ATM system.

- To achieve basic increases in airport capacity and en route/transition sector capacity.

- To create a digital communications system architecture that permits implementing a variety of data link services (space, terrestrial, airport surface, administrative) without requiring multiple data links or excessive overhead communication burdens.

- To create a new level of safety and operational efficiency by developing a full-time airport surface traffic management system.

- To create an ATM system for oceanic areas and remote land areas that emulates United States domestic airspace standards by using new surveillance, navigation, and communications technologies.

- To use environmental information from participating aircraft in operating the ATM system.

- Data and recommendations to develop approach standards for closely spaced dual, triple, and quadruple runways

Table 2–1, Major Capacity and Air Traffic Management Technology Products, provides a quick overview of major capacity–enhancing products from R,E&D research efforts.

Table 2–1. Major Capacity and Air Traffic Management Technology Products

Program Number	Program Name	Major Products
021–110	Advanced Traffic Management System (ATMS)	• FAA/Industry Data Exchange • Ground Delay Program Enhancements • FAA/Industry Collaborative Decisionmaking • Decision Support Systems for NAS Analysis
021–140	Oceanic Air Traffic Automation	• Oceanic data link prototype and related system interfaces • Prototype oceanic flight data processor replacement • Prototype integrated display capability
021–200	Surface Movement Advisor	• System specifications, statements of work, and interface requirements for national implementation • Dynamic surface traffic management planning process for integration of taxiing aircraft with arrivals and departures • Full–scale, interactive airfield/tower simulator to realistically replicate busiest airline, air traffic control, and airport operations
021–220	Multiple Runway Procedures Development	• Data and recommendations to develop approach standards for closely spaced dual, triple, and quadruple runways • ATC simulation evaluations of IFR procedures for triple and quadruple parallel runways using existing and improved runway monitoring systems
021–230	Wake Vortex Separation Standards	• Recommendations on aircraft classifications and separation standards • Wake vortex motion and decay algorithms • Wake vortex separation algorithms for TATCA
022–110	Traffic Alert and Collision Avoidance System (TCAS)	• Installation of TCAS I on 10 to 30 seat turbine-powered commuter aircraft • TCAS II transition program report documenting TCAS II implementation program results and any required modifications • ICAO standards and recommended practices that provide a basis for international certification and operational approval
022–140	General Aviation and Vertical Flight Program	• Nonprecision and precision GPS approach terminal instrument procedures criteria • Civil Tiltrotor Development Advisory Committee final report to Congress • Atlanta Olympics short–haul transportation system demonstration
022–150	Flight Operations and Air Traffic Management Integration	• Flight operations procedures and standards for FMS-guided terminal operations nationwide • Flight operations procedures and standards for FMS-guided en route and oceanic operations • Required functional capabilities document for next generation ATM-compatible reduced cost FMS-like avionics
023–120	Separation Standards	• Strategic plan for oceanic separation reductions • Data packages to support the implementation of safe separation reductions
024–110	Aviation Systems Capacity Planning	• Aviation Capacity Enhancement Plan • Airport Capacity Design Team Plans • System Performance Measurement Indicators

Table 2–1. Major Capacity and Air Traffic Management Technology Products

Program Number	Program Name	Major Products
025–130	Air Traffic Models and Evaluation Tools	• Enhanced SIMMOD airport and airspace simulation model • Dynamic traffic density tool • NASSIM executable engineering model
025–140	System Performance and Investment Analysis	• Annual NAS performance baselines • Reports on airspace and airport operational analyses • Performance bulletin providing guidance on using each analysis' results for improving operation and investments
025–150	Free Flight Implementation	• Area navigation approach procedures at major airports • New general aviation routes for major terminal areas • Procedures for real–time management and use of special use airspace

2.1 Capacity and Air Traffic Management Technology Program Descriptions

021–110 Advanced Traffic Management System (ATMS)

Purpose: In the current traffic flow management process, the aviation industry has limited opportunities to optimize the use of their own resources such as aircraft, flight crews, and other economic factors when coping with National Airspace System (NAS) system constraints. The ATMS program, now referred to as the Traffic Flow Management (TFM) New Functionalities development component of the Air Traffic Management Integrated Product Team, has been restructured to focus on building collaborative decisionmaking and decision support tools that will allow FAA traffic flow managers to work cooperatively with industry in responding to NAS congestion conditions.

Approach: This program addresses four major interrelated research areas: FAA/industry data exchange, collaborative decisionmaking (CDM) ground delay program enhancements, expanded CDM, and decision support systems for NAS analysis. The FAA/industry data exchange area serves as the foundation for all subsequent development by defining the appropriate exchange data, providing the mechanisms by which that data is shared, and enhancing the timeliness of operational data. The CDM ground delay program enhancements build upon the initial data exchange to improve the scheduling precision of the current ground delay program while increasing user scheduling flexibility. The expanded CDM area further enhances the traffic flow management process by providing the tools and technologies for more direct dialogue and interaction between the FAA and system users. The final area, decision support systems for NAS analysis, will allow the FAA to monitor, manage, and identify enhancements to the traffic flow management system.

Each discrete development activity within the four research areas will proceed through four stages of development. The initial stage, concept exploration, will explore operational and/or technology concepts for their potential application to identified operational problems. The second stage, concept development, applies operational/technology concepts to identified problems in a more rigorous, simulated, but non–operational environment to determine their suitability for further development. The third stage, prototype development, establishes an on–line capability to finalize operational procedures and system design. Following a decision to implement the capability through the fourth stage, full–scale development, there may be a corresponding decision to continue the use of the prototype for operational purposes to continue accruing the operational benefits pending completion of the full–scale development.

Related Projects: 021–140 Oceanic Air Traffic Automation, 021–200 Surface Movement Advisor, and 022–150 Flight Operations and Air Traffic Management Integration. Capital Investment Plan programs: A–05 Traffic Management System (TMS) and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Volpe National Transportation Systems Center
  Cambridge, Massachusetts

- Metron
  Reston, Virginia

Products:

FAA/Industry Data Exchange

- Aircraft situation display data to the aviation industry
- Data exchange for ground delay program enhancements
- Airport configuration information
- NAS status information
- Dynamic special use airspace information

CDM Ground Delay Program Enhancements

- Flight schedule monitor
- Ration by schedule
- Flow management decision support system enhancements
- Flight substitution process simplification
- Schedule compression
- Control by time of arrival
- Probabilistic flow management initiatives

Expanded Collaborative Decisionmaking

- Initial severe weather planning capability
- Collaborative rerouting
- Interactive flight planning capability

Decision Support Systems for NAS Analysis

- System impact assessment capability
- Performance assessment capability
- Automated problem recognition capability
- Compliance monitoring capability
- Dynamic density monitor

1996 Projected Accomplishments:

- Completed design and test of aircraft situation display data to aviation industry communications link.
- Installed prototype and began evaluation of the data exchange for the ground delay program enhancements.
- Installed prototype and began evaluation of the flight schedule monitor.
- Installed prototype and began evaluation of the ration by schedule ground delay program enhancement.

1997 Projected Accomplishments:

- Develop initial ground delay program enhancements.
- Complete concept exploration for performance assessment capability.
- Complete concept exploration for compliance monitoring capability.
- Transition aircraft situation display data to aviation industry communications link to full–scale development.
- Begin prototype development for the dynamic special use airspace information capability.

- Transition prototype data exchange for the ground delay program enhancements to full–scale development.

- Transition prototype flight schedule monitor, ration by schedule, schedule compression, and flight substitution process simplification to full–scale development.

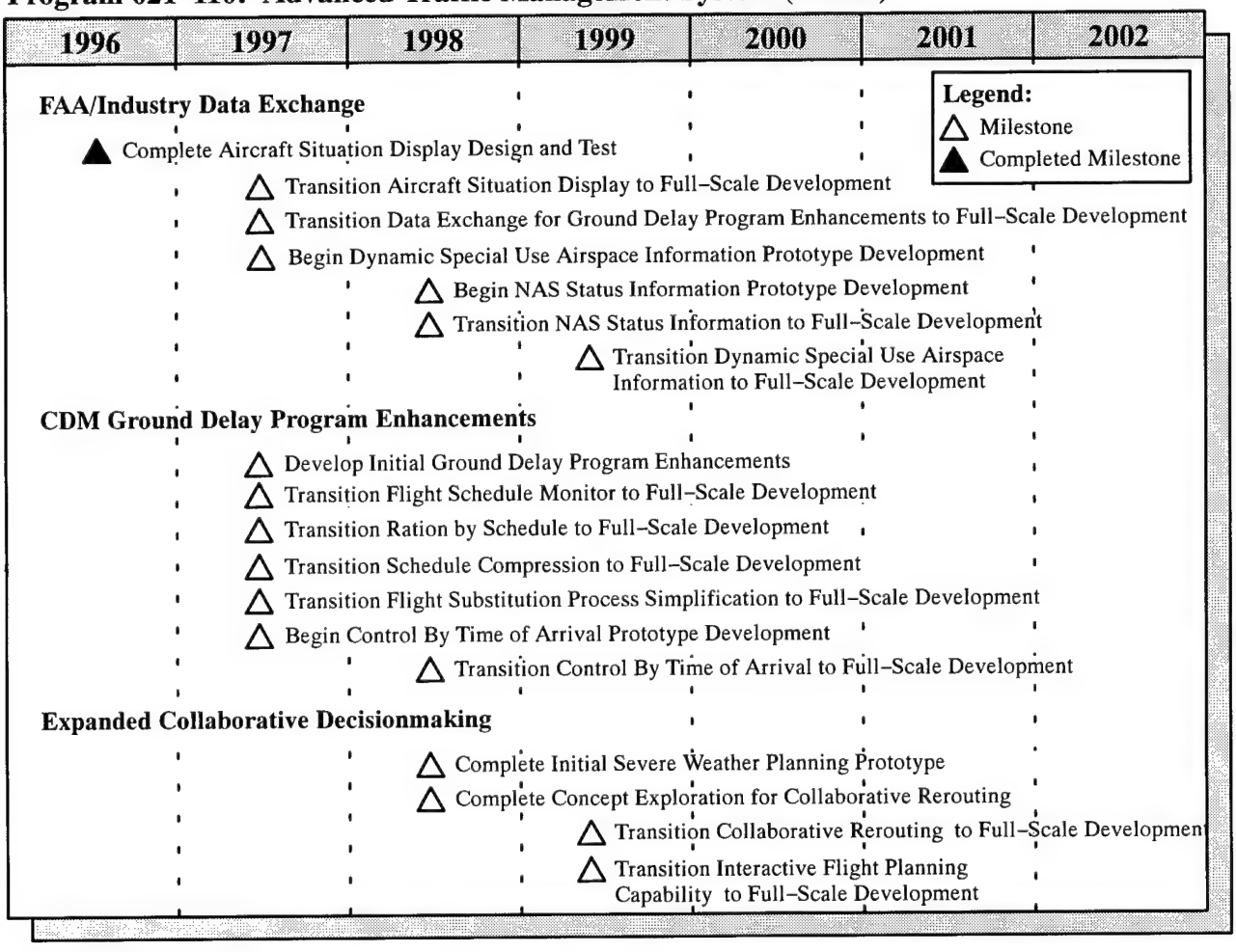
- Initiate concept exploration for decision support systems for NAS analysis capabilities, and initiate concept demonstration for expanded CDM.

- Begin control by time of arrival prototype development.

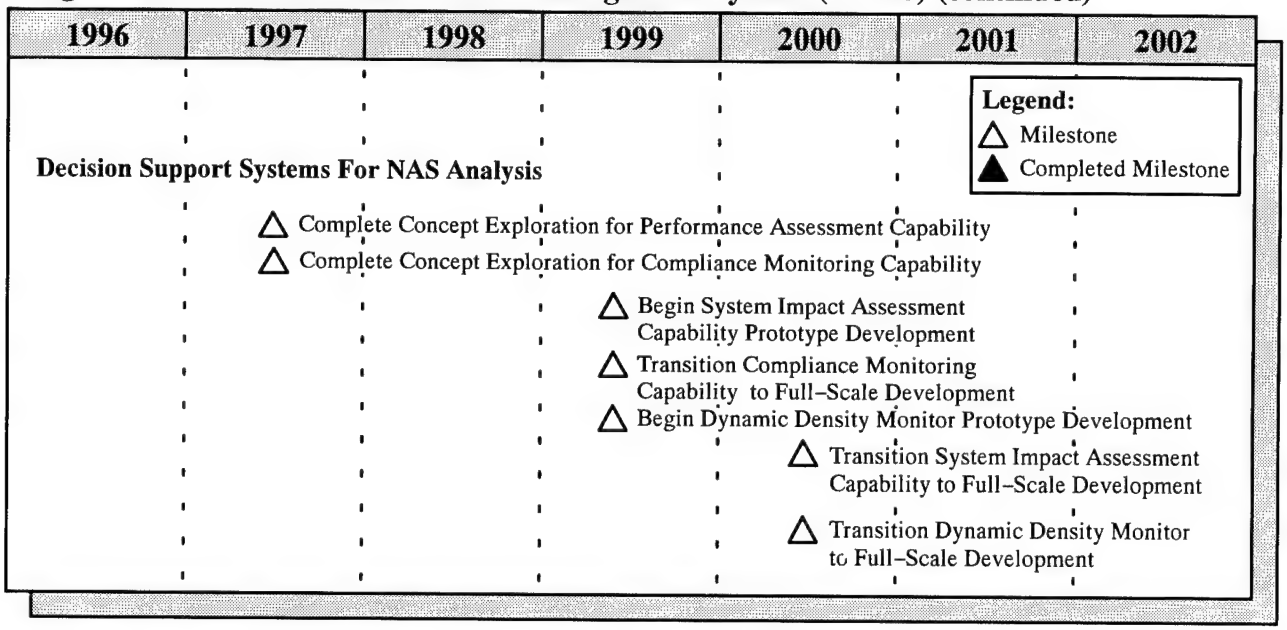
Planned Activities:

In 1998, the NAS status information capability, collaborative rerouting, interactive flight planning capability, and compliance monitoring capability will begin prototype development. Also in 1998, the NAS status information capability and control by time of arrival will transition to full scale development. In 1999, prototype development will begin on the system impact assessment capability and the dynamic density monitor. Also in 1999, the dynamic special use airspace information capability, collaborative rerouting, interactive flight planning capability, and compliance monitoring capability will transition to full scale development. In 2000, system impact assessment capability and dynamic density monitor will transition to full scale development.

Program 021–110: Advanced Traffic Management System (ATMS)



Program 021–110: Advanced Traffic Management System (ATMS) (continued)



* 021–140 Oceanic Air Traffic Automation

Purpose: With radar coverage unavailable and aircraft navigation limited to onboard systems, the current oceanic air traffic control system is significantly different from the domestic NAS. In addition to being largely manual, the system depends on air/ground communications through a third party via HF radio, subject to atmospheric anomalies and human error, to obtain position reports and maintain aircraft separation. This lack of reliable and timely position information in turn requires large aircraft separation standards, severely limiting the useable system capacity. As a result, oceanic users are rarely able to obtain maximum fuel efficiency, minimum travel times, and access to preferred takeoff times and flight paths. This program is aimed at developing new abilities to increase oceanic air traffic capacity and efficiency without degrading safety. Research and development in this program will provide the foundation for new initiatives that will be pursued through facilities and equipment, leading to the introduction of free flight in oceanic airspace.

Approach: Research and development for automation of the oceanic air traffic control system will support the objectives of the advanced oceanic automation system (AOAS) being developed and implemented through the oceanic system development and support (OSDS) contract and other related activities. The OSDS effort will develop and implement new technologies gradually through a series of builds in three separate phases. This approach will reduce technical risk, increase operator involvement in the development process, and deliver capabilities to the user community as soon as possible. In addition to the OSDS contract, studies and analyses in related areas will provide insight into areas such as system safety, measurement of benefits to users, and changes needed in

* *In 1998, this program will incorporate research from program 023–120 Separation Standards.*

international standards and procedures to fully utilize new technology.

In addition to AOAS and OSDS efforts, two prototypes currently under development will continue in support of Phase 1 of the OSDS. An oceanic data link (ODL) prototype will allow direct controller/pilot data communications via satellite. The prototype ODL will be expanded from a one–sector to a multi–sector prototype at the Oakland Center. This capability will allow for a dramatic increase of service and user–preferred routings in the oceanic domain. The second prototype, the air traffic services interfacility data communications (AIDC), will exchange flight planning information between adjacent foreign flight information regions such as Canada and Russia. AIDC is designed to eliminate time–consuming manual operator inputs and the bulk of time–consuming voice coordination across international boundaries.

Build I of OSDS will implement a national oceanic data link based on the ODL prototype and AIDC described above at all oceanic facilities. Additional research and development activities leading to this objective include development of interfaces between the prototype ODL and related operational systems, and development and test of a prototype capability to process automatic dependent surveillance (ADS) data.

Build II will provide the equipment infrastructure necessary to support system enhancements in subsequent phases. Build IIA will replace the current flight data processing system. Research and development activities leading to this objective include analysis of options for communication processor replacement and development of a prototype flight data processor replacement, and related studies and analyses. Build IIB will add an enhanced situation display, electronic flight data, and an advanced conflict probe. Research and development activities leading to this objective include requirements definition and coordination as well as related studies and analyses.

Builds I and II constitute the baseline AOAS. the following products are preplanned improvements that depend on future funding availability for implementation.

Product I will provide enhancements and new capabilities to automate flight separation planning and verification.

Product II will develop and deploy oceanic traffic flow management and air traffic control applications that support optimization of oceanic operations.

Product III will include residual tasks necessary to complete development of the endstate AOAS leading to an oceanic free flight environment.

Research and development activities supporting the preplanned product improvements include requirements definition and coordination and evaluation of metrics and benefits.

Related Projects: 021–110 Advanced Traffic Management System (ATMS), 022–140 General Aviation and Vertical Flight Program, 023–120 Separation Standards, 031–110 Aeronautical Data Link Communications and Applications, 031–120 Satellite Communications Program, and 032–110 Satellite Navigation Program. Capital Investment Plan programs: A–10 Oceanic Automation Program (OAP), F–14 System Support Laboratory Sustained Support, and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Hughes Aircraft
  Fullerton, California
  (Studies, Analyses, and Prototype Development)

Products:

- Build I: National Oceanic Data Link with foreign Flight Information Region interface
- Build II: Enhanced flight data processing capability and open systems architecture
- Product I: Automated flight separation planning and verification
- Product II: Advanced display features, weather products and controller productivity tools
- Product III: system completion and transfer leading to free flight capability

1996 Accomplishments:

- Completed ODL system requirements analysis.
- Installed AIDC flight information region–to–flight information region data link prototype in the Russian Far East.

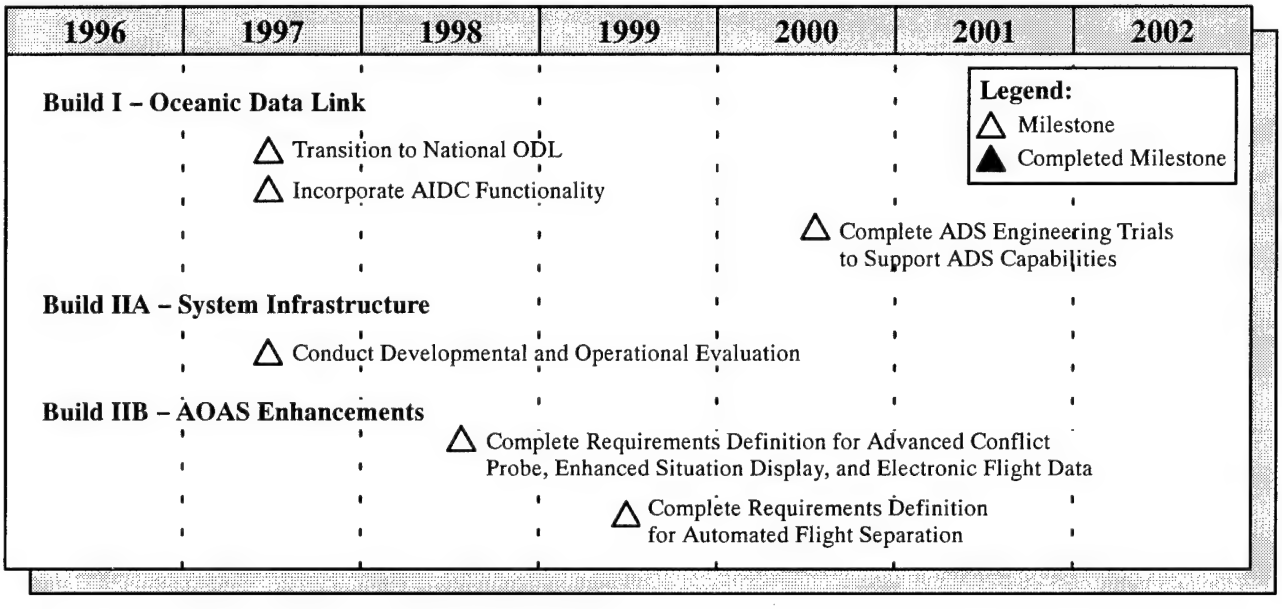
1997 Projected Accomplishments:

- Transition air traffic services interfacility data communication functionality into the national ODL.
- Develop flight data processor replacement prototype.
- Deploy prototype multisector ODL in Oakland and New York Centers.
- Conduct ADS engineering trials.

Planned Activities: In 1998, contingent upon funding, Build IIB activities will include requirements definition for advanced conflict probe, enhanced situation display and electronic flight data.

In 1999, contingent upon funding, preplanned product improvement activities will include requirements definition for automated flight separation planning and verification. Completion of ADS engineering trials to support ADS capabilities is expected in 2000.

Program 021–140: Oceanic Air Traffic Automation



021–200 Surface Movement Advisor (SMA)

Purpose: Surface congestion, caused by a lack of coordinated surface information, can create havoc for both arrivals and departures and place a "choke–hold" on an airport. All airport users share two major goals: moving arrivals promptly off the runway to parking, and minimizing departure delays. The surface movement advisor will interface with and enhance other NAS management systems and coordinate surface activities with air traffic control, the airlines, and airport operators. SMA provides unprecedented sharing of dynamic, operationally critical surface movement information to manage surface resources more efficiently.

Approach: To safely increase the capacity of existing airports, more efficient use must be made of existing airport surface resources such as taxiways, aprons, aircraft servicing facilities, runways, and gates. The SMA was conceived to address the problems associated with ground taxi delays at large airports. The SMA is intended to monitor ground movement on the airport surface and reduce surface delays. SMA will provide a collaborative decision making capability among ATC, the airlines, and airport operators. SMA is planned to be implemented and deployed through at least three interdependent builds.

SMA Build 1 implements a baseline system that provides information on airport configuration, aircraft arrival/departure status, and airfield ground movement advisories. This information is provided to air traffic controllers, area supervisors, traffic management coordinators, airport managers, and airline dispatchers. Additionally, SMA introduces a decentralized situational awareness tool that shows air traffic controllers the effects that arriving/departing aircraft have on airport ramps, taxiways, and runways. SMA provides controllers with status and advisory information through a display located within airport, terminal, and en route air traffic control facilities. Airport managers and airline dispatchers will receive SMA information through remote access data feeds. This direct feed gives these users unprecedented access to aircraft movement and status data.

SMA Builds 2 and 3 will provide enhanced functionality to the baseline system. Build 2 will integrate SMA with the center terminal radar approach control (TRACON) automation system to enhance controller efficiency in coordinating arrival/departure flows with surface movements. Build 3 integrates surface movement functionality with airport surface detection equipment (ASDE–3), airport movement area safety system (AMASS), and the airport surface target identification system (ATIDS) surveillance detection capabilities and runway incursion alerts.

An important aspect of this program is developing the surface development and test facility (SDTF), a full scale, high fidelity simulator facility that realistically emulates tower and airfield operations. Future surface functionalities will be developed, in cooperation with NASA, to further reduce surface delays and optimize airport capacity. A collaborative departure scheduling tool will be developed and supported by tower/cockpit data link technologies and other planning tools.

Related Projects: 021–110 Advanced Traffic Management System (ATMS). Capital Investment Plan programs: A–02 Tower Automation Program, A–05 Traffic Management System (TMS), and A–12 Airport Surface Target Identification System (ATIDS).

University/Contractor Support:

- NASA Ames Research Center
  Moffet Airfield, California
- NASA Langley Research Center
  Langley Field, Virginia

Products:

- Concept development and demonstration of surface management products
- Communications architecture validation
- Preproduction prototype in an operational setting
- System specifications, statements of work, and interface requirements for SMA Build 1 national implementation
- Dynamic surface traffic management planning process for integration of taxiing aircraft with arrivals and departures streams
- Capability for automatic coordination of surface traffic management activities with other ATC automation systems
- Full–scale, interactive airfield/tower simulator that realistically replicates airport operations with the users and developers

1996 Accomplishments:

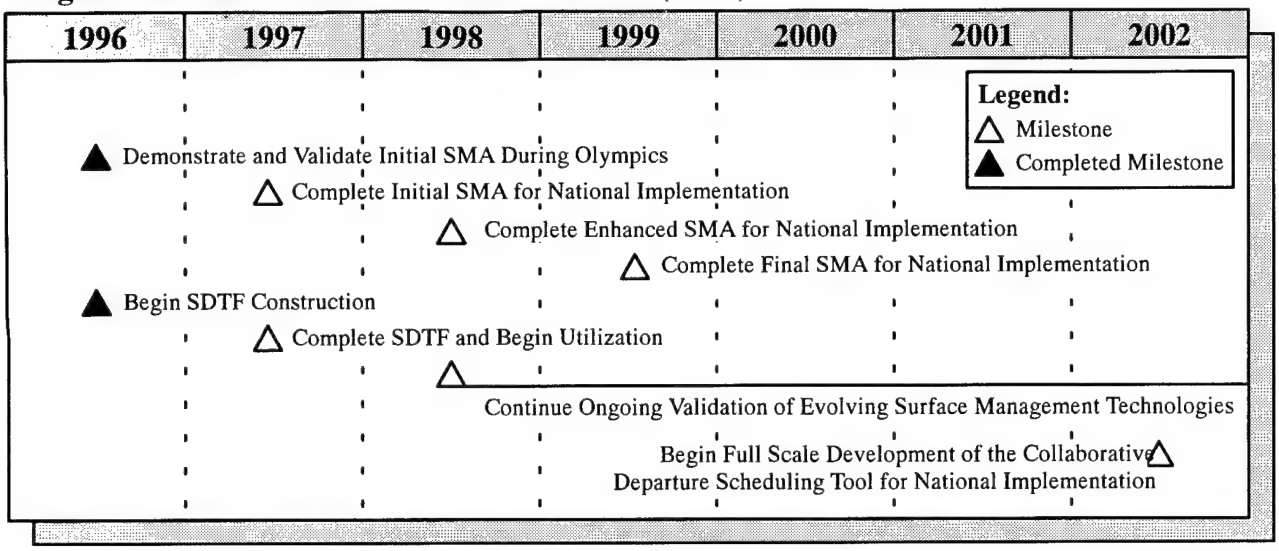
- Completed demonstration and validation of initial prototype during the Summer Olympics at Hartsfield–Atlanta International Airport.
- Constructed full–scale, interactive tower/airfield simulator structure.
- Completed draft detailed system specification for integration of the initial version of SMA Build 1 into the tower domain.

1997 Projected Accomplishments:

- Deliver final system level specification, statement of work, and interface requirements for national implementation of the SMA Build 1.
- Complete demonstration and validation of SMA Build 2 prototype.
- Complete full–scale, interactive tower/airfield simulator and begin utilization by the airlines, air traffic controllers, and airport operators for realistic functional testing and validation of all new surface management technologies.

Planned Activities: In 1998, the final system level specification, statement of work, and interface requirements for national implementation of SMA Build 2 will be delivered. Also in 1998, a draft system specification for integrating SMA Build 3 into the tower domain will be completed. The full–scale tower/airfield simulator will continue to be utilized by the airlines, air traffic controllers, and airport operators for realistic functional testing and validation of all evolving surface management technologies. In 1999, the final detailed SMA system specification for national implementation into the tower domain will be completed.

Program 021–200: Surface Movement Advisor (SMA)



021–220 Multiple Runway Procedures Development

Purpose: This program will develop ATC procedures to reduce airport delays by more fully utilizing multiple-runway capacity during instrument meteorological conditions. This program will investigate the use of advanced surveillance techniques in conjunction with advanced avionics for reducing parallel runway spacing standards to less than 3,400 feet. Advanced surveillance techniques include precision runway monitor (PRM) technology with electronically scanned antenna systems and high update rates. Air traffic procedures and flight standards criteria for simultaneous triple and quadruple instrument flight rules (IFR) parallel approaches will also be developed and validated. Requirements and techniques for improved surveillance and navigation capabilities will be developed to support these procedures.

Approach: The FAA has completed demonstrations of electronically scanned and "back-to-back" antenna PRM technologies resulting in acceptance of simultaneous, independent approaches to dual parallel runways spaced as closely as 3,400 feet. The PRM Program Office upgraded the Raleigh-Durham PRM system to commissionable status, and PRM installation has been completed at Minneapolis/St. Paul. Further PRM installations are planned for St. Louis, JFK, Philadelphia, and Atlanta or Pittsburgh. Additionally, real-time simulations have shown the value of a final monitor aid, based on high-resolution color displays with a controller alert aid. These displays receive surveillance inputs from airport surveillance radar (ASR)-9 or mode select (Mode S) discrete addressable secondary radar system with data link, for monitoring parallel runway operations.

This program will conduct additional simulations and analyses to develop national standards and ATC procedures for parallel runways using PRM and final monitor aid technologies. Further research efforts on reducing runway spacing standards will focus on allowing approaches to parallel runways with less than 3,400 feet separation. The results of these studies for dual parallel runways will provide the basis for

developing the spacing standards for closely spaced triple and quadruple parallel runways. This program will provide data and recommendations to the Air Traffic and Flight Standards Services for formulating standards and procedures.

Related Projects: 024–110 Aviation System Capacity Planning and 051–110 Airport Planning and Design Technology. Capital Investment Plan programs: A–12 Airport Surface Target Identification System (ATIDS), F–14 System Support Laboratory Sustained Support, F–15 General Support Laboratory Sustained Support, M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance, N–12 Augmentations for the Global Positioning System (GPS), and S–08 Precision Runway Monitor.

University/Contractor Support:

- MITRE Corporation
  McLean, Virginia

- Lincoln Laboratory
  Lexington, Massachusetts

Products:

- Data and recommendations to develop approach standards for closely spaced dual, triple, and quadruple runways

- ATC simulation evaluations of IFR procedures for triple and quadruple parallel runways using existing and improved runway monitoring systems

1996 Accomplishments:

- Recommended national standards for dual parallel runways with 3,000 feet spacing using the PRM and offset localizer.

- Developed recommendations for simultaneous triple parallel approach procedures using PRM for two selected airports.

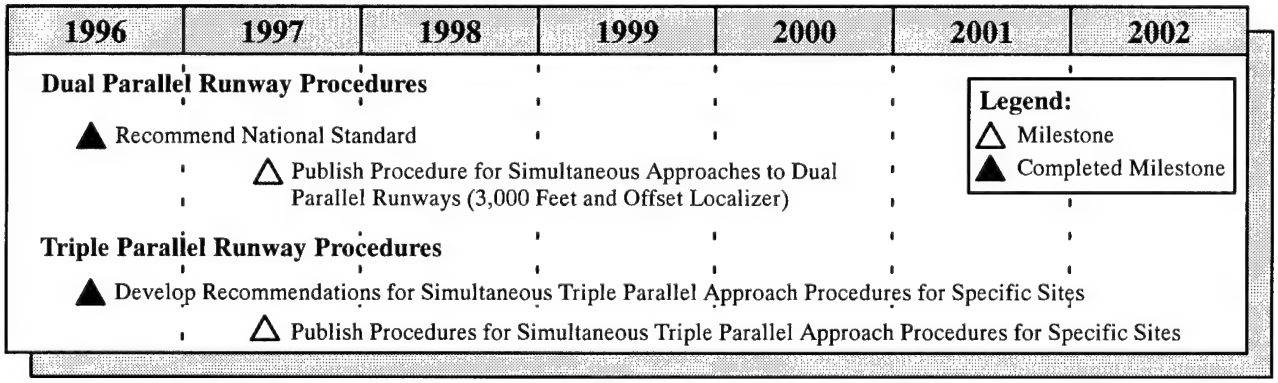
- Completed enhancement to the collision risk model for parallel runways.

1997 Projected Accomplishments:

- Publish procedure for simultaneous approaches to dual parallel runways with 3,000 feet spacing using the PRM and offset localizer.

Planned Activities: In 1998, research will continue to develop procedures and concepts for enhancing terminal area capacity and safety. From 1998 and beyond, this program will investigate integrating new and emerging technologies such as the global positioning system, data link, and ground automation systems to develop standards that maximize airport throughput in adverse weather conditions.

Program 021–220: Multiple Runway Procedures Development



021–230 Wake Vortex Separation Standards

Purpose: Wake vortices, particularly those generated by large transport aircraft, can present significant hazards to following aircraft in single runway operations. Parallel runway operations may also be severely affected by vortices which can propagate great distances while in ground effect. This program will focus on safely reducing arrival and departure separation standards leading to increased capacity in the terminal area. These gains will be accomplished by understanding wake vortex strength, duration, and transport characteristics, particularly as the vortices experience ground effect in the terminal environment. Potential methods to detect and avoid wake vortices will be examined to enhance airspace use, decrease delays, and increase airport capacity in instrument meteorological conditions.

Approach: Current air traffic operations will be assessed to determine actual traffic spacing used under visual flight rules conditions. Vortex strength, decay, and transport characteristics, as well as the meteorological conditions that affect these characteristics, will be examined at selected, high traffic airports. Data from previous wake vortex tests and other collected data will be combined with new data to provide a basis for reviewing existing separation standards and recommending modifications. Flight test simulations will be designed and conducted to determine if reducing the separation standards currently used under IFR conditions is feasible. Issues such as closely spaced parallel and converging runways, departure delays, and potential departure sequencing will also be explored through simulation.

The FAA's research and test activities will be conducted by the Volpe National Transportation Systems Center. In addition, a joint effort with the National Aeronautics and Space Administration (NASA) to develop models and simulation techniques that characterize wake vortex hazards has been outlined in a memorandum of agreement.

Related Projects: 024–110 Aviation System Capacity Planning and 042–110 Aeronautical Hazards Research. Capital Investment Plan programs: W–07 Integrated Terminal Weather System (ITWS).

University/Contractor Support:

- Ohio University
  Athens, Ohio
- Pennsylvania State University
  State College, Pennsylvania
- Princeton University
  Princeton, New Jersey
- Massachusetts Institute of Technology
  Cambridge, Massachusetts

Products:

- Recommendations on aircraft classifications and separation standards
- Wake vortex motion and decay algorithms
- Wake vortex sensor requirements
- Wake vortex detection systems
- Wake vortex separation algorithms for terminal air traffic control automation (TATCA)

1996 Accomplishments:

- Developed initial wake vortex transport and decay model in ground effect.
- Recommended revised aircraft spacing/classification standards.

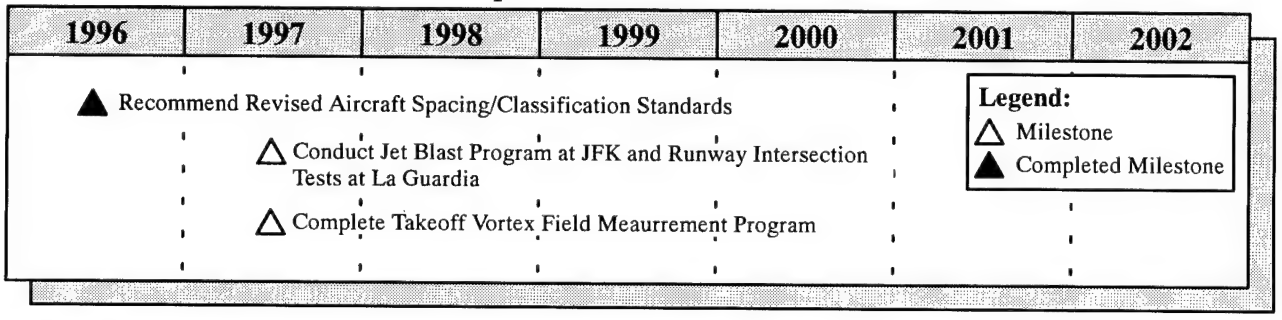
- Selected sensor technology for further development.
- Published results of takeoff vortex test program.
- Completed joint test program with NASA Langley Research Center at Memphis International Airport.
- Reestablished vortex test site at JFK International Airport.

1997 Projected Accomplishments:

- Complete takeoff vortex field measurement program.
- Conduct jet blast test program at JFK International Airport and provide recommendations for separation standards behind departures.
- Conduct takeoff vortex test program at La Guardia Airport and provide recommendations for reduced separations on intersecting runways.
- Conduct joint test program with NASA Langley Research Center to evaluate vortex sensor techniques and vortex motion and decay algorithms.
- Coordinate test activities with the United Kingdom leading to reduced takeoff separations at Heathrow International Airport.
- Coordinate test activities with Germany leading to independent landing operations to parallel runways at Frankfurt International Airport.
- Develop a computer-based wake vortex training program.

Planned Activities: Due to budget constraints and higher priorities, this project has been deferred or cancelled indefinitely in FY 1998 and beyond.

Program 021–230: Wake Vortex Separation Standards



022–110 Traffic Alert and Collision Avoidance System (TCAS)

Purpose: This project will develop, demonstrate, and assist in implementing an independent airborne collision avoidance capability to increase the safety and capacity of the National Airspace System. TCAS will increase safety by reducing midair collision risks. Capacity will be increased by using the improved cockpit display capability provided by TCAS to aid capacity

enhancements such as simultaneous approaches to parallel runways and pilot-maintained in-trail spacing. The aviation community will be provided with standards and certification guidance materials required for implementing the system.

Approach: There are two TCAS versions: I and II, each with successively increasing capabilities. TCAS I is under evaluation through a limited implementation program (LIP). TCAS II operational implementation has been completed; however, development work on enhanced logic changes will continue.

TCAS I

TCAS I generates traffic advisories to assist pilots in locating potential midair collision threats. The FAA has established a cost-shared contract with an avionics manufacturer to furnish TCAS I avionics for an LIP evaluation on several types of in-service commuter aircraft. This effort will provide operational and performance data on commercial TCAS I equipment in actual service.

TCAS II

TCAS II equipment, which includes a Mode S transponder, is intended for installation in transport category and high performance general aviation aircraft. TCAS II equipment will not only provide traffic advisories but will also compute vertical-plane resolution advisories that indicate the direction the aircraft should maneuver to avoid collisions. To ensure that maneuvers from two TCAS-equipped aircraft do not conflict, resolution advisories are coordinated between aircraft using the integral Mode S transponder.

Through an LIP, an operational TCAS II evaluation has been carried out on a number of in-service airline aircraft. Federal Aviation Regulations now require that all airplanes with more than 30 passenger seats operating in U.S. airspace be equipped with TCAS II. Development efforts will continue to enhance TCAS II by resolving technical and operational issues associated with implementation.

Related Projects: 024–110 Aviation System Capacity Planning and 031–110 Aeronautical Data Link Communications and Applications. Capital Investment Plan projects: F–15 General Support Laboratory Sustained Support, M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance, M–15 National Airspace System Spectrum Engineering Management, and S–02 Mode S.

University/Contractor Support:

- MITRE (CAASD)
  McLean, Virginia
- MIT Lincoln Laboratory
  Lexington, Massachusetts
- ARINC Research
  Annapolis, Maryland
- Volpe National Transportation Systems Center
  Cambridge, Massachusetts

Products:

TCAS I

- LIP — Reports on the TCAS I avionics evaluation to provide industry with guidance for TCAS I certification and operation
- Installation of TCAS I on 10 to 30 seat turbine-powered commuter aircraft by December 31, 1995

TCAS II

- LIP — Reports on TCAS II installation, certification, and operation on air carrier aircraft during routine operations
- TCAS II transition program report documenting TCAS II implementation program results and any required modifications
- TCAS II requirements document for certification in transport category aircraft
- ICAO standards and recommended practices that provide a basis for international certification and operational approval

1996 Accomplishments:

- Conducted TCAS II transition program.
- Completed TCAS IV surveillance subsystem design. (Note: TCAS II provides traffic advisories and computes vertical–plane resolution advisories. TCAS IV was designed to increase the capabilities of TCAS II by providing resolution advisories in both the horizontal and vertical planes. Due to budget priorities, TCAS IV research will be discontinued in FY 1997 and beyond.)

1997 Projected Accomplishments:

- Complete assessment and publish resolution advisory downlink report.
- Complete TCAS II Change 7.0 logic upgrade.
- Develop TCAS II ATC applications (in–trail climb).

Planned Activities:

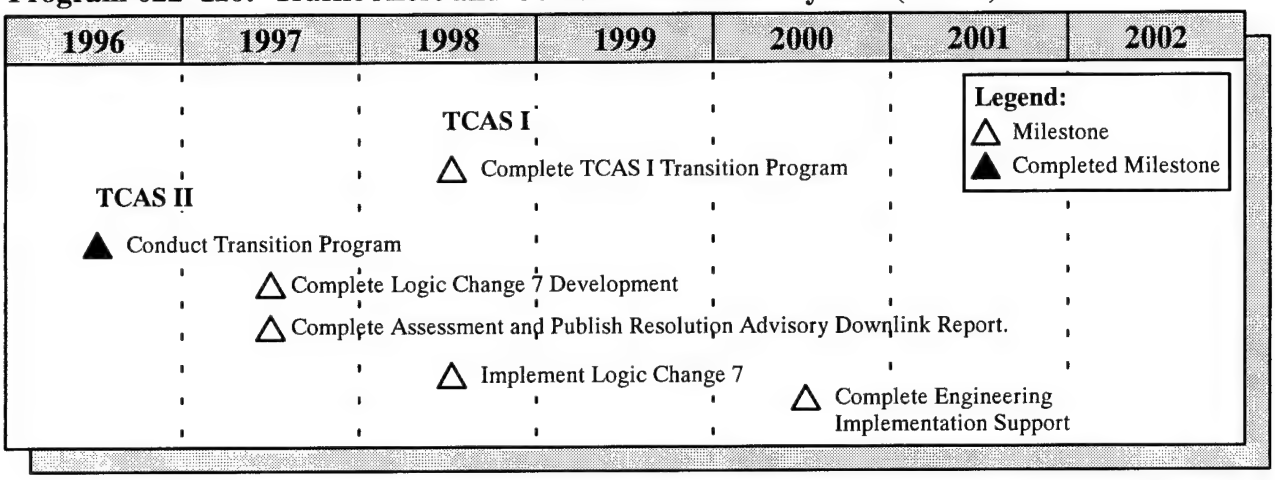
TCAS I

The FAA will continue a multiyear transition program to assist aircraft operators with TCAS I implementation in the National Airspace System. The transition program will continue through 1998. Periodic transition program reports will provide guidance on installation, crew training, and system operation.

TCAS II

In accordance with Federal Aviation Regulations, all commercial aircraft with more than 30 passenger seats were required to be equipped with TCAS II by December 30, 1993. The FAA will continue to work with the aviation community to resolve technical and operational issues associated with TCAS II implementation. In 1998, Logic Change 7 implementation will begin. Engineering support will continue through 2000.

Program 022–110: Traffic Alert and Collision Avoidance System (TCAS)



022–140 General Aviation and Vertical Flight Program

Purpose: In response to the FAA's goals to adopt a free flight concept and revitalize the general aviation industry while improving the general aviation safety record, this program will identify, initiate, and coordinate actions to facilitate introducing and expanding technology applicable to general aviation and vertical flight into the NAS. Research, engineering, and development efforts will focus on air traffic system design, integration, and advanced operational procedures; heliport/vertiport/intermodal design and planning; aircraft/aircrew certification, training, and human factors; and emerging technology applications.

The major portion of the general aviation element of this program is a collaborative NASA/FAA/industry technology program. The major objectives are to implement an economically viable and safe short–haul transportation system existing within and in concert with the national airspace system, stimulate the industry, and create jobs for airframe manufacturers, the propulsion industry, avionics shops, airports, and supporting industries. Research will include the rapid introduction of new cockpit display and control technologies; integrated ATC procedures; expert decisionmaking systems; enhanced airspace utilization; enhanced ground/cockpit information systems; and other technology initiatives.

Approach: Through the use of collaborative partnerships with industry, the General Aviation and Vertical Flight Office, in cooperation with other federal and state government agencies such as NASA and the U.S. Department of Defense (DOD), will continue to produce near– and mid–term research product initiatives to implement an advanced short–haul transportation system. This system will be designed in parallel with and will contribute to the evolving NAS architecture. A major emphasis of these research initiatives will be to create partnerships with the aviation and local communities early in the design phase.

The program will focus on the following technical project areas: air infrastructure, ground infrastructure, and aircraft/aircrew human machine interface. Research in these areas, which emphasizes general aviation and vertical flight requirements, is designed to complement other R,E&D programs.

Air Infrastructure

This project will provide research to enable reliable, all-weather operations for general aviation and vertical flight passenger and cargo aircraft. The research results will include developing nonprecision and precision global positioning system (GPS) terminal instrument approach and departure procedures criteria; developing rotorcraft instrument flight rules approach and departure ascent/descent angles; establishing low altitude communications, navigation, and surveillance for air traffic control services using GPS technology, multiple data links, and free flight functionality; and developing noise mitigation technologies.

Ground Infrastructure

The ground infrastructure research will address airport, heliport, and vertiport design and planning issues, including the terminal area facilities and ground-based support systems that will be needed to implement safe and affordable, near all-weather, 24-hour flight operations. Developing obstacle avoidance capabilities, advanced approach lighting technologies, and an integrated graphical pre–flight planning system are critical design-related efforts. Research will include enhanced ground/cockpit information systems, noise abatement, increased airport utility, and applying lessons learned from detailed accident/operations analyses.

Aircraft/Aircrew

Aircraft/aircrew research will: evaluate state-of-the-art flight performance for cockpit design technology; develop improved training techniques to enhance decisionmaking reactions; and develop crew and aircraft performance standards for display and control integration requirements. Research will also be conducted to develop certification standards for both conventional and advanced technology aircraft. Training procedures will be established to reduce the human element causal factor in general aviation and vertical flight accidents.

Related Projects: 021–140 Oceanic Air Traffic Automation, 022–150 Flight Operations and Air Traffic Management Integration, 024–110 Aviation System Capacity Planning, 025–140 System Performance and Investment Analysis, 031–110 Aeronautical Data Link Communications and Applications, 031–120 Satellite Communications Program, 032–110 Satellite Navigation Program, 051–130 Airport Safety Technology, 062–110 Advanced Materials/Structural Safety, 064–110 Flight Safety/Atmospheric Hazards, 081–110 Flight Deck, Aircraft Maintenance, Flight Deck/ATC, System Integration Human Factors, and 091–110 Environment and Energy.

University/Contractor Support:

- JIL Information Systems
  Crystal City, Virginia
- NYMA, Inc.
  Greenbelt, Maryland
- SAIC
  Crystal City, Virginia
- Prutzman and Associates
  Frederick, Maryland
- MITRE Corporation
  McLean, Virginia
- ARNAV, Inc.
  Puyallup, Washington

- Advanced Aviation Concepts
  Melbourne, Florida
- Ohio State University
  Columbus, Ohio
- Georgia Tech Research Institute
  Atlanta, Georgia
- Florida Institute of Technology
  Melbourne, Florida
- University of Tennessee Space Institute
  Tullahoma, Tennessee
- Virginia Space Consortium
  Norfolk, Virginia

Products:

- Nonprecision and precision GPS approach terminal instrument procedures criteria
- New cockpit technologies
- ATC route standards, procedures, and models
- Vertiport/heliport design standards
- Improved noise planning tools
- Vertical flight noise abatement procedures
- Aircrew training and certification requirements
- Cost/benefit assessments for deploying advanced aircraft technologies
- Civil Tiltrotor Development Advisory Committee final report to Congress
- Community Involvement Implementation Plan
- Atlanta Olympics short–haul transportation system demonstration

1996 Accomplishments:

- Conducted the annual general aviation innovative aircraft design competition jointly with NASA.
- Established a training work package for the NASA/FAA/industry advanced general aviation transport experiments (AGATE) project.
- Developed GPS non–precision approach terminal instrument procedures (TERPS) criteria for vertical flight aircraft.
- Demonstrated Atlanta Olympics short–haul transportation system.
- Developed and certified an airborne communications/navigation/surveillance (CNS/A) avionics prototype.
- Completed and delivered the civil tiltrotor development advisory committee final report to Congress.
- Developed and field tested advanced aeronautical decisionmaking products for the Aviation Safety Program.
- Developed and demonstrated the first integrated services digital network (ISDN) pilot pre–flight briefing workstation.

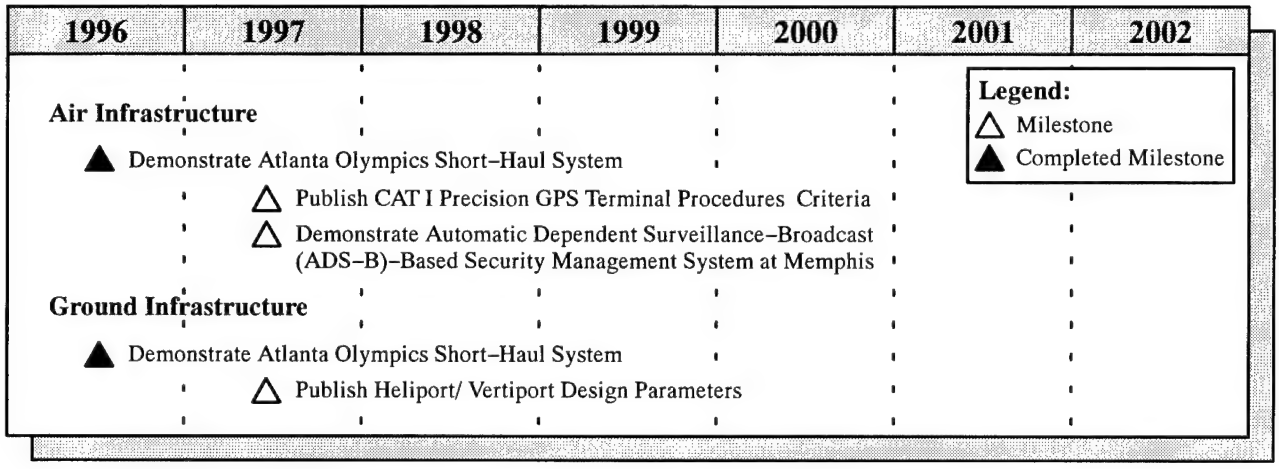
1997 Projected Accomplishments:

- Demonstrate automatic dependent surveillance–broadcast (ADS–B)–based security management system at Memphis.

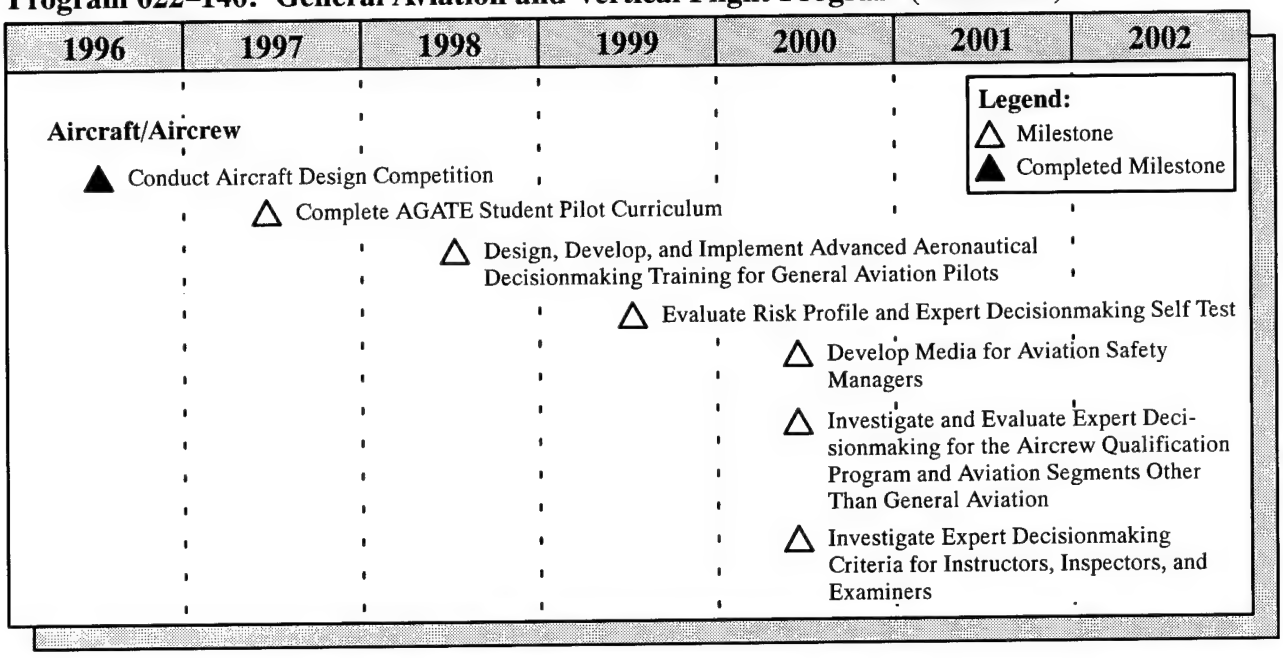
- Complete phase one for establishing non-precision GPS approaches to all qualifying emergency medical facilities in the United States.
- Analyze the Atlanta short-haul transportation system demonstration data and produce the final reports.
- Initiate the air and ground infrastructure work packages for AGATE.
- Develop training technologies and certification criteria for AGATE pilot training.
- Begin flight testing of rotorcraft GPS precision approaches.
- Conduct the annual general aviation innovative aircraft design competition jointly with NASA.
- Develop federal/state airborne weather dissemination model.
- Develop preproduction CNS/A hardware and design guidelines.

Planned Activities: In 1998, advanced aeronautical decisionmaking training for general aviation pilots will be designed, developed, and implemented. In 1999, an expert decisionmaking training manual will be field tested. Also in 1999, a risk profile and expert decisionmaking self test will be evaluated. In 2000, media for the Aviation Safety Managers Program will be developed. Also in 2000, expert decisionmaking for the Aircrew Qualification Program and aviation segments other than general aviation will be investigated and evaluated in coordination with the R,E&D Human Factors program. Expert decisionmaking criteria for instructors, inspectors, and examiners will also be investigated.

Program 022-140: General Aviation and Vertical Flight Program



Program 022–140: General Aviation and Vertical Flight Program (continued)

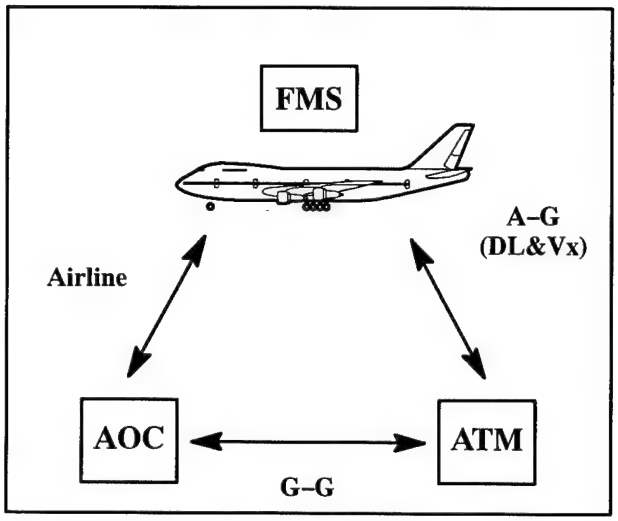


* 022–150 Flight Operations and Air Traffic Management Integration

Purpose: A cornerstone of the future air traffic management system will be direct information exchange between flight management system (FMS) computers and ground-based ATM computers via data link. Current FMS utilization in today's air traffic system environment is estimated by the user community at approximately 30 percent. This underutilization has resulted in the need to better integrate the aircraft FMS with the ground ATM. This program will develop the capability to integrate flight management computer operations with ground-based air traffic management automation. Integrating FMS and ATM operations via data link is expected to increase airspace capacity and ensure more efficient flight operations along more flexible, conflict-free routes.

Approach: Integrating FMS with ATM in the near term can be accomplished by adapting existing procedures to take advantage of FMS capabilities to save distance, fuel, and time on the aircraft side. On the ATM side, there will be a reduction in communications and associated workload. Future airborne flight management systems and ground air traffic management systems must be designed to ensure compatibility between systems as well as to gain true synergistic benefits from integration. This program utilizes the concept that integration of ATM automation with both the aircraft FMS and aeronautical operational control (AOC) will deliver this synergistic benefit. Without this three–way tie, this benefit will not be achieved. The primary focus of this program is the integration of FMS with ATM. This integration must encompass all operational areas where the FMS is used to gain overall system benefits. These areas include terminal, en route, and oceanic airspace as well as the airport surface. The secondary focus is integration of ATM with AOC.

* *Will be combined with program 031–110 Aeronautical Data Link Communications and Applications in 1998.*



FMS/ATM/AOC Integration Concept

This program is an enhancement to programs that only investigate ground–to–ground or air–to–ground integration, but not a system encompassing the two.

This program's primary objective continues to be development and validation of a set of required FMS/ATM capabilities. These required capabilities will be used by industry to create standards for building the next generation FMS and retrofitting current technology aircraft. These required capabilities will also be used to drive enhancements to ATM automation. This work continues through a cooperative agreement between the FAA and industry. Additionally, work will be done toward a lower cost aircraft system that will take advantage of current satellite technology to afford some of the air carrier ATM/FMS services to the regional airline, commuter, and lower–end general aviation community. An additional product will be developing FMS and FMS-like flight operations and procedures that benefit from the new information exchange between the aircraft flight deck and the ground ATM system.

This program employs a service–based approach for determining air/ground applications as well as identifying functional FMS and ATM capabilities. An operational concept has been completed that describes 24 potential FMS/ATM services.

This program will perform system analyses focusing on operational viability, technical feasibility, and cost/benefit to both user community and service providers. The result of this process will be a set of required FMS/ATM capabilities, a benefit analysis report, and candidate procedures and flight standards that will allow implementation of those services that would yield benefit.

This program will continue to support working groups such as the Industry/FAA Advanced FMS Applications Task Force. The task force is involved in creating new procedures using existing FMS capabilities for curved approaches and departures at selected airports. Procedures validation will be accomplished through data collection/analysis, simulation, and flight testing. These procedures will then be adapted to support FMS–guided terminal operations nationwide.

Related Projects: 021–110 Advanced Traffic Management System (ATMS), 021–200 Surface Movement Advisor; 022–140 General Aviation and Vertical Flight Program, and 031–110 Aeronautical Data Link Communications and Applications. Capital Investment Plan programs: A–02 Tower Automation Program, A–05 Traffic Management System (TMS), and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

- Crown Communications, Inc.
  Washington, D.C.

Products:

- Flight operations procedures and standards for FMS-guided terminal operations nationwide
- Flight operations procedures and standards for FMS-guided en route and oceanic operations
- Benefit analysis report for FMS/ATM services

- Required FMS/ATM functional capabilities document
- Required functional capabilities document for next generation ATM-compatible reduced cost FMS-like avionics

1996 Accomplishments:

- Completed Advisory Circular, AC120.CNS.
- Completed FMS/ATM/AOC operational concept document.
- Completed FMS/ATM/AOC minimum aviation system performance specification.

1997 Projected Accomplishments:

- Complete cost/benefit analysis and report for ATM/FMS services.
- Develop procedures and standards for ATM/FMS services.

University/Contractor Support:

- Complete initial phase of simulation and validation testing of ATM/FMS services.
- Complete procedures and guidance materials for public use FMS–guided terminal operations at selected airports.

Planned Activities: In 1998, the required FMS/ATM functional capabilities document will be completed. Additionally, in 1998 work will be completed for implementation of public use FMS terminal procedures nationwide.

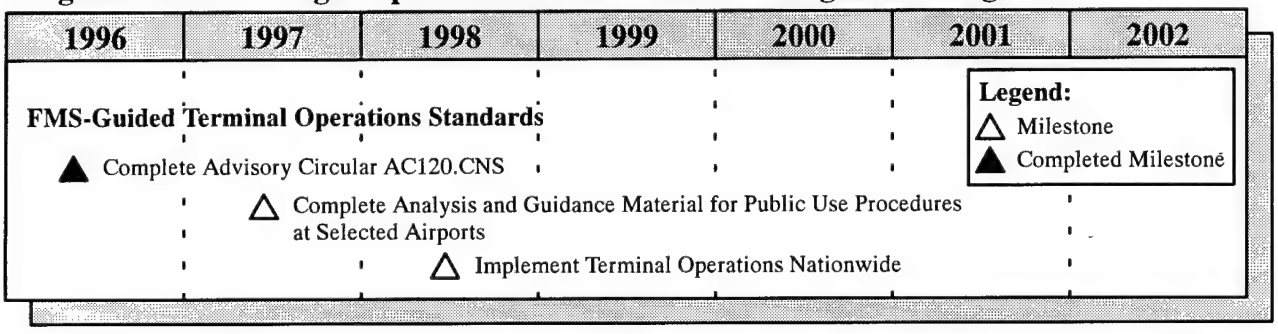
In 1998–1999, further simulation experiments involving flight operations and air traffic management scenarios will be conducted. Procedure validation will be conducted in parallel to simulations, and will be completed by 2000. Flight standards and guidance material will be completed in 2001.

In 1998, work will begin on obtaining international agreement on the ATM-compatible FMS requirements document by 2000.

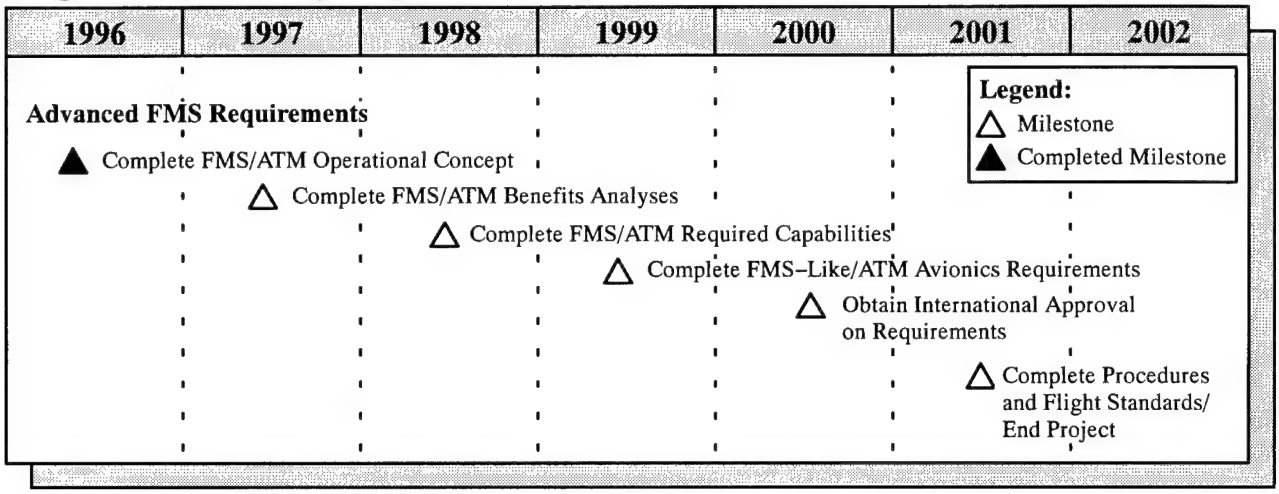
Efforts will continue toward development of a functional requirements document for next generation ATM-compatible reduced cost FMS-like avionics by 1999.

This program is projected to end in 2001 when the next–generation FMS/ATM procedures and flight standards are in place.

Program 022–150: Flight Operations and Air Traffic Management Integration



Program 022–150: Flight Operations and Air Traffic Management Integration (cont.)



* 023–120 Separation Standards

Purpose: The existing separation standards are the primary capacity restraint in oceanic airspace. The ability to increase system capacity is directly related to reducing separation standards. This program will provide quantitative guidance for international efforts to establish minimum vertical and horizontal separation standards. As new technology is introduced, separation standards will be reduced, resulting in increased system capacity. Another benefit will be significant improvements in fuel efficiency from flying more optimum flight profiles.

Approach: Tests will be conducted to provide quantitative guidance for determining oceanic separation minima permissible as new technologies are introduced. This effort will establish separation minima based on improved navigation, automatic dependent surveillance, other new technologies, and ATC improvements.

This program will analyze separation standards in the North Atlantic, South Pacific, Central East Pacific, North Pacific, and Western Atlantic Route Systems airspace. The program will examine the impact of various system improvements on horizontal and vertical separation. Time-based navigation capabilities and associated ATC procedures will be analyzed to determine whether time-based longitudinal separation standards or distance-based standards are more appropriate. An assessment of when free flight can be safely supported with planned technologies and procedures will be developed.

Related Projects: 021–140 Oceanic Air Traffic Automation, 031–110 Aeronautical Data Link Communications and Applications, 031–120 Satellite Communications Program, and 032–110 Satellite Navigation Program. Capital Investment Plan programs: A–10 Oceanic Automation Program (OAP), F–15 General Support Laboratory Sustained Support, and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

* *Will be combined with program 021–140 Oceanic Air Traffic Automation in 1998.*

University/Contractor Support:

- Volpe National Transportation Systems Center
  Cambridge, Massachusetts

Products:

- Strategic plan for oceanic separation reductions
- Reports on reduced horizontal oceanic separation feasibility
- Report on international general guidance material for establishing separation standard minima
- Data packages for coordinating international horizontal oceanic separation standards
- Reduced vertical separation data analyses, operational tests, and evaluations
- Data to support rulemaking to enable reduced separation standards

1996 Accomplishments:

- Completed the implementation of the GPS–based monitoring system in support of the North Atlantic reduced vertical separation minimum.
- Completed analysis in support of fifty nautical mile lateral separation standard.
- Collected verification data for fifty nautical mile lateral and fifty nautical mile longitudinal separation standards.

1997 Projected Accomplishments:

- Complete regional traffic and aircraft performance monitoring and analysis.
- Implement reduced vertical separation minimum for operational trials.
- Conduct reduced vertical separation verification flight trials in the North Atlantic.
- Conduct flight trials of 50 nautical mile lateral and 50 nautical mile (seven minute) longitudinal separation for future air navigation system (FANS) 1 aircraft in the Pacific airspace.
- Enhance the collision risk model assessing the combined effects on aircraft separation of automatic dependent surveillance, global positioning system navigation, and controller pilot data link communication.
- Develop plans for reduced vertical separation minimum implementations in the Pacific and Western Atlantic route systems.
- Initiate research and development efforts for aircraft–to–aircraft separation and free flight separation in the oceanic region.

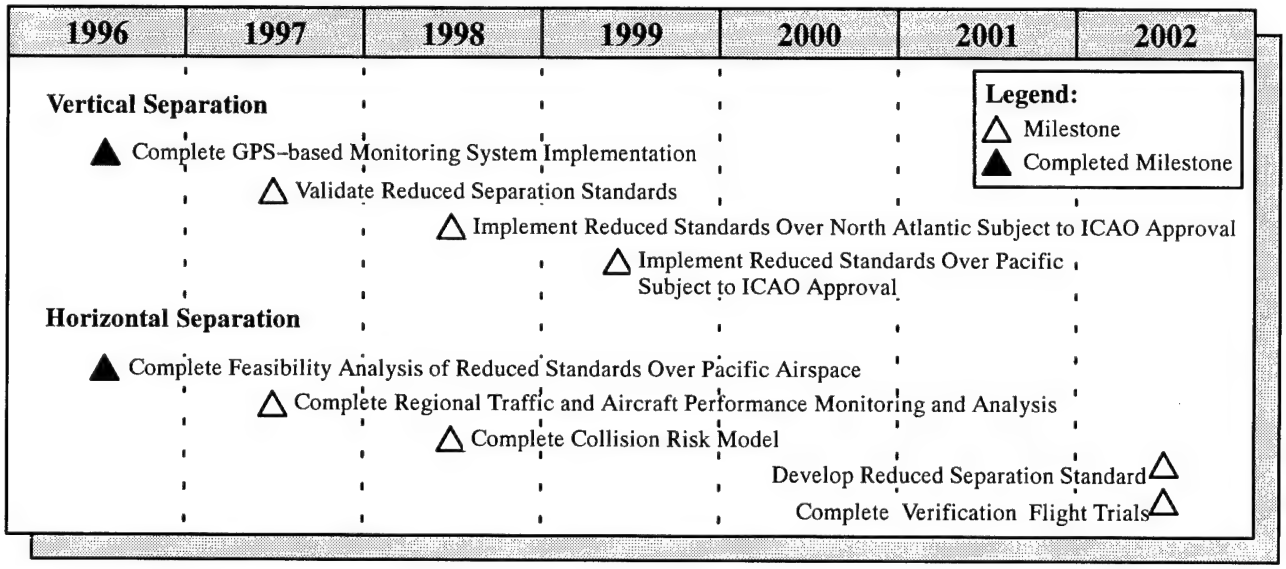
Planned Activities: In 1998, the enhanced collision risk model will be completed. The North Atlantic Systems Planning Group will continue the implementation of vertical separation reduction over the North Atlantic. Also in 1998, flight trials will continue with the reduced separation standard of 1,000 feet vertical above flight level 290 in the North Atlantic, and the reduced standard will be expanded to other areas of the North Atlantic airspace. ICAO approval is possible for implementing vertical separation standards in Pacific airspace by 1999. Additional regional analyses will be conducted through 2001 to support the FAA's goal of having a global oceanic vertical separation standard. The analyses will determine if certain oceanic regions will require a deviation from a global standard or if a global standard will suffice for all areas. ICAO approval on a standard is expected by 2003.

In 1998, a feasibility demonstration will be conducted for 30 nautical miles lateral/30 nautical miles longitudinal separation for FANS 1–equipped aircraft in the Pacific airspace.

Also in 1998, research and development efforts will continue for oceanic free flight

From 1998–2002, additional verification flight trials and analyses will be conducted in other oceanic regions to develop a global standard that reduces horizontal separation to 30 miles. As technology advances and regional traffic increases, analyses and operational trials will be conducted on a 15 nautical mile separation standard. After 2002, this developmental standard will enter the ICAO approval process to develop a worldwide standard. The FAA's goal is to eventually reduce oceanic horizontal separation standards to near-domestic limits (approximately 5 miles). Research to meet this goal will be undertaken where there is both a demand and an economic benefit.

Program 023–120: Separation Standards



024–110 Aviation System Capacity Planning

Purpose: Twenty-two major metropolitan airports currently experience over 20,000 hours of annual delay due to capacity restraints. As the aviation industry continues to grow, the number of affected airports will increase, with projections showing 29 experiencing 20,000 hours of delay by 2004. This program supports development of an overall capacity strategy, the conduct, measurement, and assessment of airports and technologies, and development and application of electronic tools that aid in the formulation of that strategy. These initiatives can be implemented to increase the number of operations per hour, reduce delays, and increase savings through lower maintenance/operating costs. This program complies with the Congressional mandate for producing airport improvement plans, responds to the aviation industry high priority initiatives for increased capacity, and responds to recommendations from the

Presidential Commission on Improved Airline Competitiveness.

Approach: A primary focus of this program is responding to near-term airport-driven capacity issues. As traffic demand at airports changes, research efforts are reallocated to meet the changing priorities. This dynamic environment is driven by constantly changing airline needs. Airport, airspace, tactical initiative, and capacity design teams currently active at 15 airports are comprised of airport operators, airlines, other users, and FAA representatives. Each team starts with a current airport and/or adjacent airspace environment simulation using actual operating data to establish a baseline. The team then develops a list of potential improvements to increase capacity and reduce delays by using a variety of simulation and queuing models, and tests their effect in the specific airport environment. Among the improvements investigated are airfield improvements such as new runways and runway extensions; improved approach procedures; and new facilities and equipment such as the precision runway monitor. Those improvements found to produce the greatest capacity increases, together with the estimated delay reductions and cost savings, are described and recommended for implementation in the final design team plans.

Design teams also address airspace structure and develop new designs and traffic flow modifications to accommodate more aircraft within the terminal airspace. Airspace redesign begins with simulating the air traffic control center airway environment using operational data to establish the baseline. The airspace design team then develops alternatives such as more direct routings; segregating jet, turboprop, and piston engine traffic; and relocating cornerpost navigational aids to allow for more arrival and departure routes. These alternatives are simulated to determine their effect on delay, travel time, sector loading, and aircraft operating cost. The most successful alternatives are then incorporated into a plan to redesign the airspace for increased capacity.

The Tactical Initiatives Team project, on the other hand, works to develop achievable, near-term solutions for chronic delay airports by focusing on resources under FAA control. This project is limited to initiatives that will produce results within 2 years.

All of these capacity efforts are supported by the development of performance measures that quantify system performance in terms that go beyond the traditional measures of delay. These new measures will make significant contributions to the system as a whole. They will allow the FAA to weigh the impact of procedural changes, airport improvements, and automation enhancement against the results they produce for the user. With such a measurement system in place, it will be possible to truly integrate budget and management activities as needed to maximize total system capacity.

Related Projects: 021–220 Multiple Runway Procedures Development, 021–230 Wake Vortex Separation Standards, 022–110 Traffic Alert and Collision Avoidance System (TCAS), 025–130 Air Traffic Models and Evaluation Tools, and 091–110 Environment and Energy. Capital Investment Plan programs: F–15 General Support Laboratory Sustained Support and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- JIL Systems
  Washington, D.C.

- Volpe National Transportation Systems Center
  Cambridge, Massachusetts

Products:

- Aviation Capacity Enhancement Plan
- Airport Capacity Design Team Plans
- Airspace Analysis Technical Plans
- Aviation Capacity Initiatives Report
- Aviation System Capacity Enhancement video
- Terminal Airspace Capacity Design Team Plans
- Tactical Initiatives Reports
- Regional Design Team Reports

1996 Accomplishments:

- Developed improved independent converging approach procedures and standards.
- Produced 1996 Aviation Capacity Enhancement Plan.
- Completed Airport Capacity Design Team plans for Atlanta, Reno, and Portland.
- Completed Airspace Analysis Technical Plans.
- Completed Tactical Initiatives Report for Dallas–Fort Worth, Boston, Orlando, Los Angeles, and Charlotte.
- Completed airspace analyses at Los Angeles (Phase II) and Dallas–Fort Worth Air Route Traffic Control Centers (ARTCC's).
- Completed Terminal Airspace Capacity Design Team plans at Tampa and Minneapolis.
- Developed an outcome–based user–focused system of performance measures.
- Completed initial baselining of nine key performance indicators.
- Completed Northeast Airport Strategic Planning Study of New York, Boston, Philadelphia, and Washington.
- Completed wake vortex separation analysis of major airports.

1997 Projected Accomplishments:

- Complete airport capacity update for Miami and Memphis.
- Complete Tactical Initiative Report for San Diego, Los Angeles, Las Vegas, and Newark.
- Complete Airport Capacity Design Team plan for Baltimore/Washington.
- Complete Terminal Airspace Capacity Design Team plan for Boston and Salt Lake City.
- Complete airspace redesign for Las Vegas and Northern and Southern California metroplex control facilities.
- Institutionalize initial performance indicators.
- Validate and baseline remaining performance indicators.
- Complete New York Regional Design Study.

Planned Activities: Airport Capacity Design Team efforts will continue at New York (JFK, LGA, and EWR), Las Vegas, and Los Angeles. The sequence of events is to conduct a study lasting approximately 12 to 18 months at each airport, followed by capacity improvement recommendations. These teams will develop Airport Capacity Design Plans for each airport by 1998.

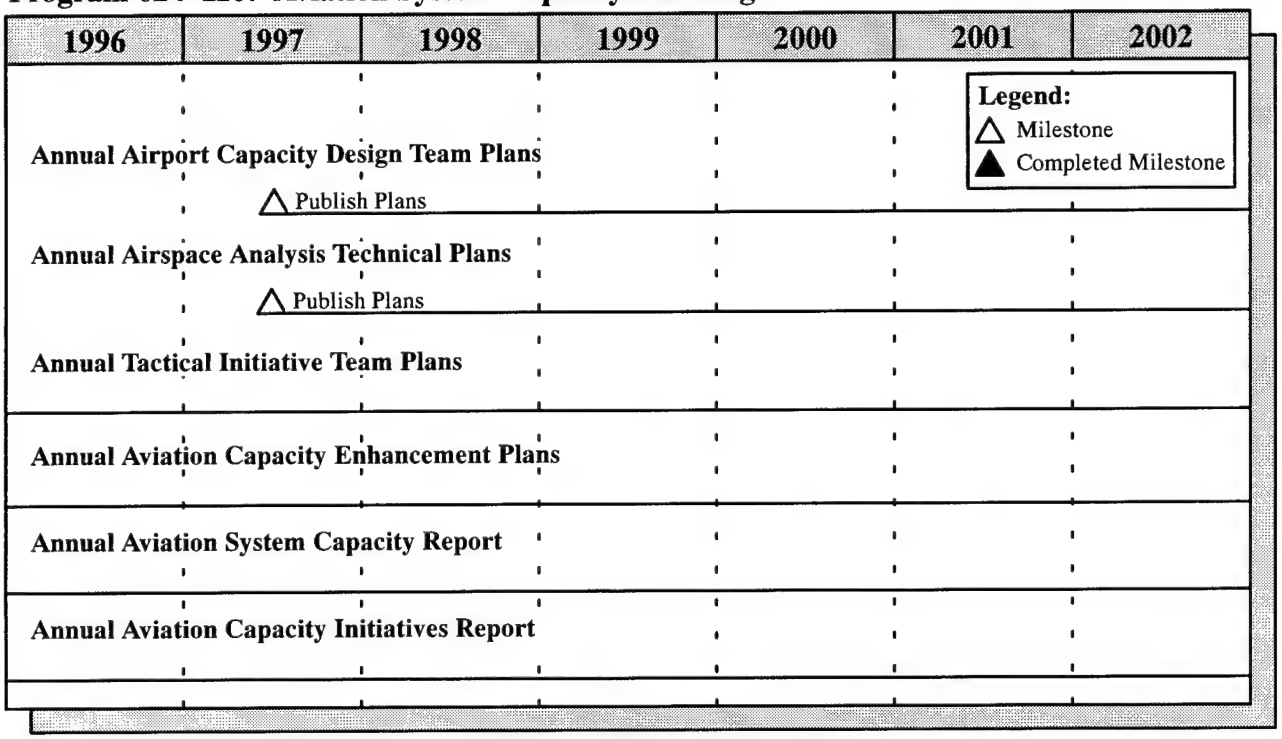
In 1998, Airspace Analysis Technical Plans will be developed for Albuquerque, Boston, and Memphis ARTCC's. These plans will lead to airspace redesigns at these locations to improve traffic flows. The sequence of events is to study these airspaces for 2 years and then issue recommendations for capacity enhancements.

From 1998 to 1999, simulations and flight demonstrations will be conducted to determine if the surveillance capabilities of TCAS can be expanded for separation assistance. A cockpit display of traffic information will play a vital role in the free flight concept. It will also be important in improving departure and arrival spacing, wake vortex avoidance, and enhanced non–radar applications. The FAA Strategic Plan goals include improved system efficiency, a reduction in controller workload, and enhanced safety.

In 1998, the Tactical Initiatives Team will investigate near-term solutions to capacity problems at airports experiencing chronic delays or undergoing major reconstruction projects. As technology evolves, the Tactical Initiatives Teams will continually analyze delay problems and develop new, near-term solutions.

The following documents will be produced annually: the Aviation Capacity Enhancement Plan, and the Aviation Capacity Initiatives Report.

Program 024–110: Aviation System Capacity Planning



* 025–130 Air Traffic Models and Evaluation Tools

Purpose: This program will produce modeling and analytic tools to support operational improvements, airspace and airport design, environmental analysis, investment decisionmaking, and ATC system design analysis. The products from this program will provide ATC with the ability to plan, evaluate, and update operational and engineering changes rapidly to accommodate the more dynamic airport/airspace environment. This program's models will respond to changing operational concepts, such as free flight, resulting from the improvements to satellite navigation, communications, and increased ATC and cockpit automation. The program will emphasize improvements to existing models and new model developments that produce the highest payoff. Modeling products will be improved to make them simpler, faster, more effective, and more widely used and accepted.

Approach: Development will focus on integrated airport and airspace modeling. Previously developed models, such as National Airspace System performance analysis capability (NASPAC) and the FAA's airport and airspace simulation model (SIMMOD), will be made easier, faster, and more flexible to use. New model variants will enable clients to make fast approximations to complex situations. SIMMOD, an FAA trademark software program, is used by the FAA, industry, and foreign governments to design airport layouts and airspace routings.

New operational concepts will result in changes to the information flow from the aircraft through the ground communications and automation systems. This program will develop an executable engineering model of the NAS infrastructure (NASSIM) to identify how these changes in the flow of information will affect new and existing systems.

A software representation of free flight will identify the data flow and process required in the free flight concept. This representation will provide a capability to review current and developmental hardware programs against free flight requirements. Analysis and development of algorithms to support free flight will be conducted. These analyses will include developing advanced conflict probes to maintain safe separation of aircraft and tools to measure dynamic traffic density.

Related Projects: 024–110 Aviation System Capacity Planning, 025–140 System Performance and Investment Analysis, and 091–110 Environment and Energy. Capital Investment Plan programs: A–05 Traffic Management System (TMS) and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Center of Excellence for Operations Research
- CSSI
  Washington, D.C.
- ATAC
  Sunnyvale, California
- Saber Decision Technologies
  Dallas/Ft. Worth, Texas

Products:

- Enhanced SIMMOD airport and airspace simulation model

** Will be combined in a new program 025–150 Free Flight Implementation in 1998.*

- SIMMOD/NASPAC capabilities installed in selected ARTCC's, TRACON's, and FAA regional offices
- NASPAC U.S. airspace simulation production model
- Critical sector detector
- Dynamic traffic density tool
- Alert and protected zone conflict tool
- NASSIM executable engineering model

1996 Accomplishments:

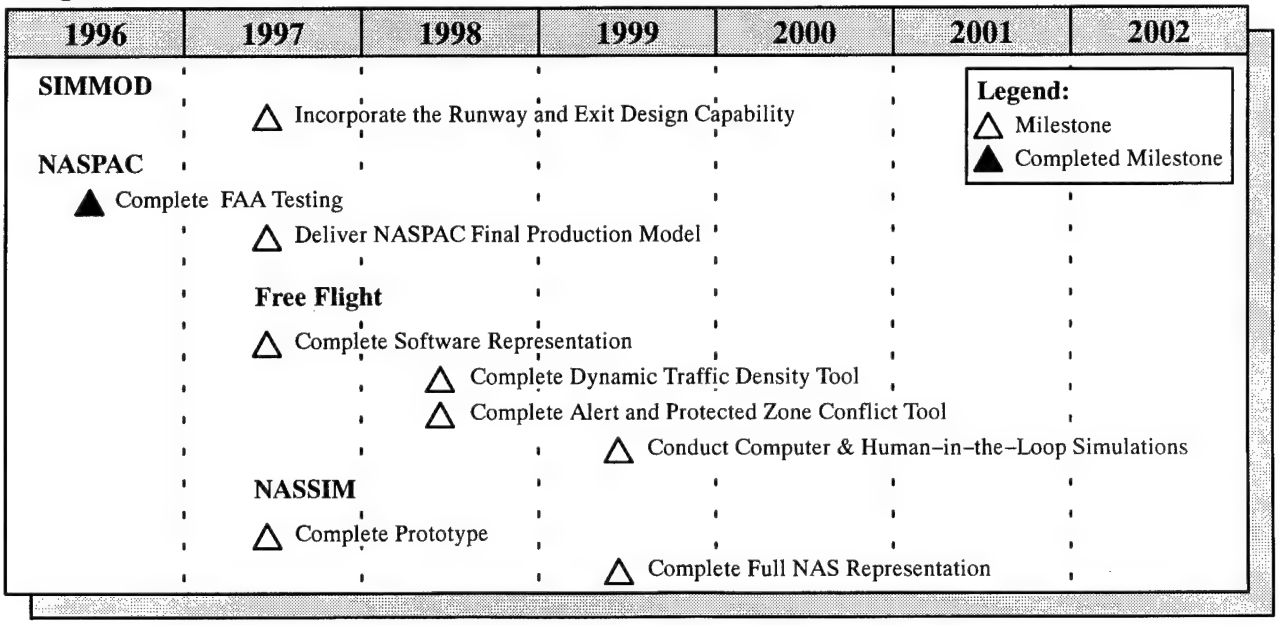
- Completed en route controller taskload measurement tool.
- Developed an aircraft trajectory model for free flight.
- Developed the total traffic tool to examine the effects of the national route program on traffic density and complexity.
- Completed final version of NASPAC.

1997 Projected Accomplishments:

- Complete NASSIM prototype and evaluate it on data link.
- Complete NASPAC testing and deliver production model.
- Incorporate runway and exit design capability into SIMMOD.
- Develop en route task load predictor for use in free flight analysis.
- Complete software representation of the free flight concept.

In 1998, a dynamic traffic density tool and an alert and protected zone conflict tool will be completed. Also in 1998, algorithms and prototypes for dynamic resectorization will be developed. Computer and human-in-the-loop simulations will be conducted in 1999 to further define the free flight concept. Also in 1999, the full NAS representation in NASSIM will be completed.

Program 025-130: Air Traffic Models and Evaluation Tools



* 025–140 System Performance and Investment Analysis

Purpose: The FAA needs to determine what R,E&D investments are needed to produce early benefits for the aviation community. Each individual R,E&D program has a narrow focus in an attempt to solve a specific issue or problem. An analysis capability is needed to more fully understand present and future problems in the context of the overall national airspace system. This program will analyze individual R,E&D programs to determine their NAS impact from a broad perspective. Information and data from this research will be used to help guide planning for R,E&D investments. For example, this program will anticipate: airport, airspace, airway facility, and other needs for improving operating efficiencies, as well as minimizing noise and safety concerns.

Approach: This program will apply models and analysis tools to develop the operational NAS baselines, conduct analyses, and provide the quantitative findings necessary for supporting/guiding R,E&D program investment decisions. State-of-the-art operations research methodologies will be used to study the dynamics and interrelationships of the NAS to define those new technologies/concepts that will have the greatest value for the aviation community. These methodologies include using mathematical models, simulations, statistical analyses, and investment analyses. This program will use the latest aviation community tools available to the FAA, other government agencies, the private sector, and academia. In particular, this program will use models and tools developed by program 025–130, Air Traffic Models and Evaluation Tools. The hallmark of this analysis capability is to provide proactive and timely findings to help resolve critical R,E&D issues. This program will work closely with other organizations, such as Air Traffic, System Capacity, and Aviation Research to complement other R,E&D programs and facilitate information transfer.

Related Projects: 021–200 Surface Movement Advisor, 022–140 General Aviation and Vertical Flight Program, 024–110 Aviation System Capacity Planning, and 025–130 Air Traffic Models and Evaluation Tools. Capital Investment Plan programs: A–01 En Route Automation Program, M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance, and S–08 Precision Runway Monitor.

University/Contractor Support:

- Center of Excellence in Operations Research
  - University of California at Berkeley
    Berkeley, California
  - Massachusetts Institute of Technology
    Cambridge, Massachusetts
  - University of Maryland at College Park
    College Park, Maryland
- CSSI
  Washington, D.C.
- MITRE (CAASD)
  McLean, Virginia

Products:

- Annual program plan
- Annual NAS performance baselines
- Reports/findings on current and future NAS performance
- Reports on airspace and airport operational analyses

* *Will be combined with a new program 025–150 Free Flight Implementation in 1998.*

- Reports/findings on R,E&D program NAS operational effectiveness
- R,E&D program and process investment analyses
- Performance bulletin providing guidance on using each analysis' results for improving operation and investments

1996 Accomplishments:

- Published report and performance bulletin on a modified future baseline of the national airspace system.
- Published report and performance bulletin on an assessment of the anticipated air traffic control system for 2010.
- Completed two reports with findings on using GPS for more efficient routing in the NAS.
- Completed evaluation of advanced separation standards on NAS performance and safety.
- Conducted investment analyses of the FY 1998 R,E&D plan and selected programs.

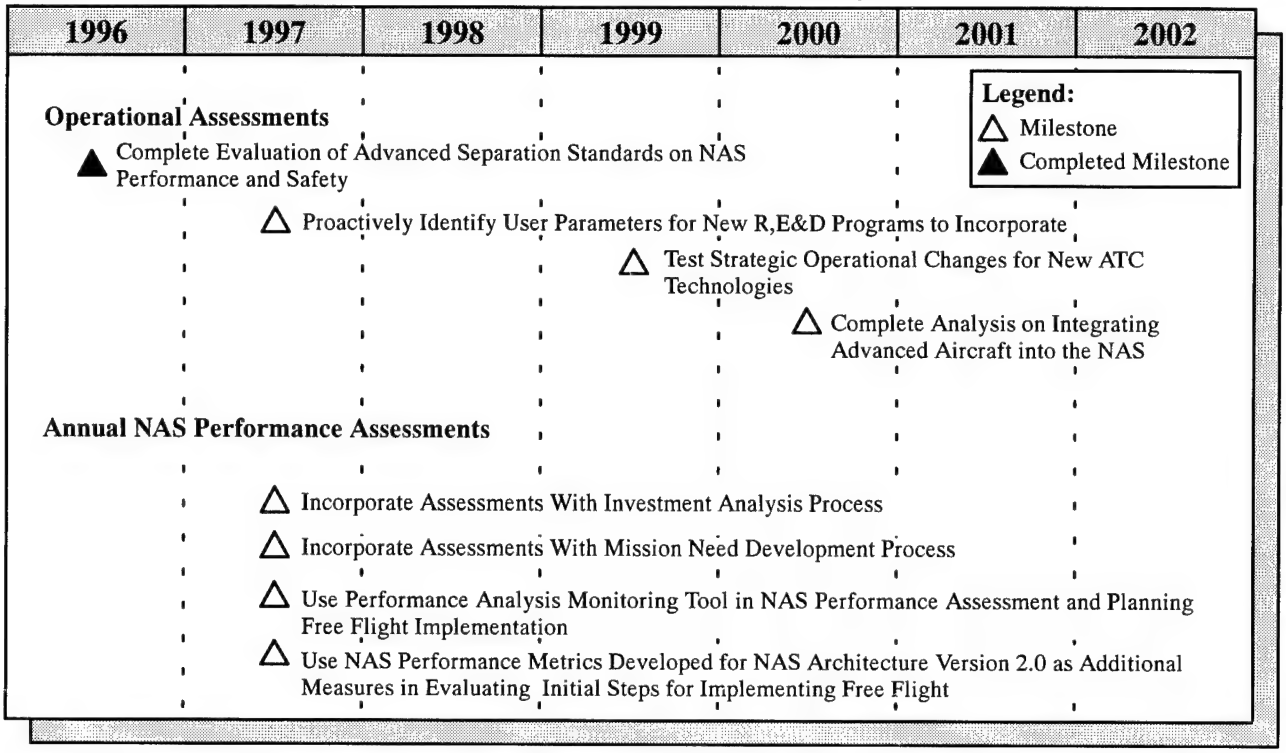
1997 Projected Accomplishments:

- Publish annual NAS performance assessment.
- Publish report on using GPS for efficient routing in terminal areas.
- Use performance analysis monitoring tool in NAS performance assessment and planning free flight implementation.
- Integrate NAS performance assessments with the R,E&D mission need development process and the investment analysis process.
- Use NAS performance metrics developed for NAS Architecture Version 2.0 as additional measures in evaluating initial steps for implementing free flight.

Planned Activities: A key product of this program is a yearly NAS performance assessment. The assessment's objective is to maintain an up-to-date NAS performance appraisal used to construct guidance for new R,E&D programs. In 1998 and beyond, this program will broaden the operational focus of the analyses to include aviation research investments, airway facilities, system capacity, and flight standards issues. Also in 1998 and beyond, operational assessments will identify critical operational changes that may be required to realize maximum benefits from new R,E&D programs.

In 1999, strategic operational changes for new ATC technologies will be tested and the findings delivered to appropriate agencies. In 2000, an analysis will be completed on integrating advanced aircraft into the NAS. Examples of these new aircraft are the high-speed civil transport and 600–800 passenger ultra-large aircraft. After 2002, this program will evaluate new ATC procedures resulting from new automation concepts for strategic air traffic management.

Program 025–140: System Performance and Investment Analysis



* 025–150 Free Flight Implementation

Purpose: The Free Flight Implementation program is designed to provide a coordinated agency research, engineering, and development response to proposals for changes in operational concepts, particularly the RTCA Taskforce 3 Report on free flight. This program joins the various agency capabilities for airspace design, procedures, and policies to provide flexibility, predictability, and access in the National Airspace System.

Approach: Research in this program will include the development of area navigation procedures to allow for greater variation in en route speeds and to accommodate user needs for greater latitude in all aspects of flight planning. Additionally, the program will develop area navigation precision approaches and departures to increase capacity of the nation's airports by ensuring the runway will not go unused due to approach and departure fix saturation or traffic flow mixes.

To provide greater access to restricted airspace, area navigation routes will be developed through the terminal area to allow equipped general aviation traffic access to constrained airspace providing time and fuel savings, and in marginal weather, safety improvements. Special use airspace trials will be conducted, and system

* *In 1998, this program will incorporate research from programs 025–130 Air Traffic Models and Evaluation Tools and 025–140 System Performance and Investment Analysis.*

specifications, standards, and communication requirements will be established to implement improvements in use and access to this airspace.

Initial analysis of requirements for reduced separations will be conducted, and procedures developed for both pilots and controllers. Human–in–the–loop simulations will be used to verify these procedures. Criteria will be developed to measure the delta in workload between increased monitoring of these closely spaced aircraft versus controller actions to preserve larger separations.

An investigation of self–separation and airborne conflict probe analyses will be initiated. The coordination of the ground–based conflict probe and the related controller/pilot workload issue with self separation will be addressed.

Increased flexibility in routing will result in shifting traffic patterns and complexity. To enable the controller to better balance these traffic changes, dynamic resectorization and density measures will be analyzed. Alternative dynamic resectorizations strategies for implementation will be explored.

Related Projects: 024–110 Aviation System Capacity Planning and 091–110 Environment and Energy.

University/Contractor Support:

- Center of Excellence for Operations Research
  - University of California at Berkeley
    Berkeley, California
  - Massachusetts Institute of Technology
    Cambridge, Massachusetts
  - University of Maryland at College Park
    College Park, Maryland
  - Virginia Polytechnic Institute and State University
    Blacksburg, Virginia

Products:

- Area navigation approach procedures at major airports
- New general aviation routes for major terminal areas
- Procedures for real–time management and use of special use airspace
- System specification for implementation of reduced horizontal separations
- Controller/pilot taskload analyses for reduced horizontal separation and self separation procedures
- Dynamic density and dynamic resectorization algorithms

1996 Accomplishments:

- New start in 1998.

1997 Projected Accomplishments:

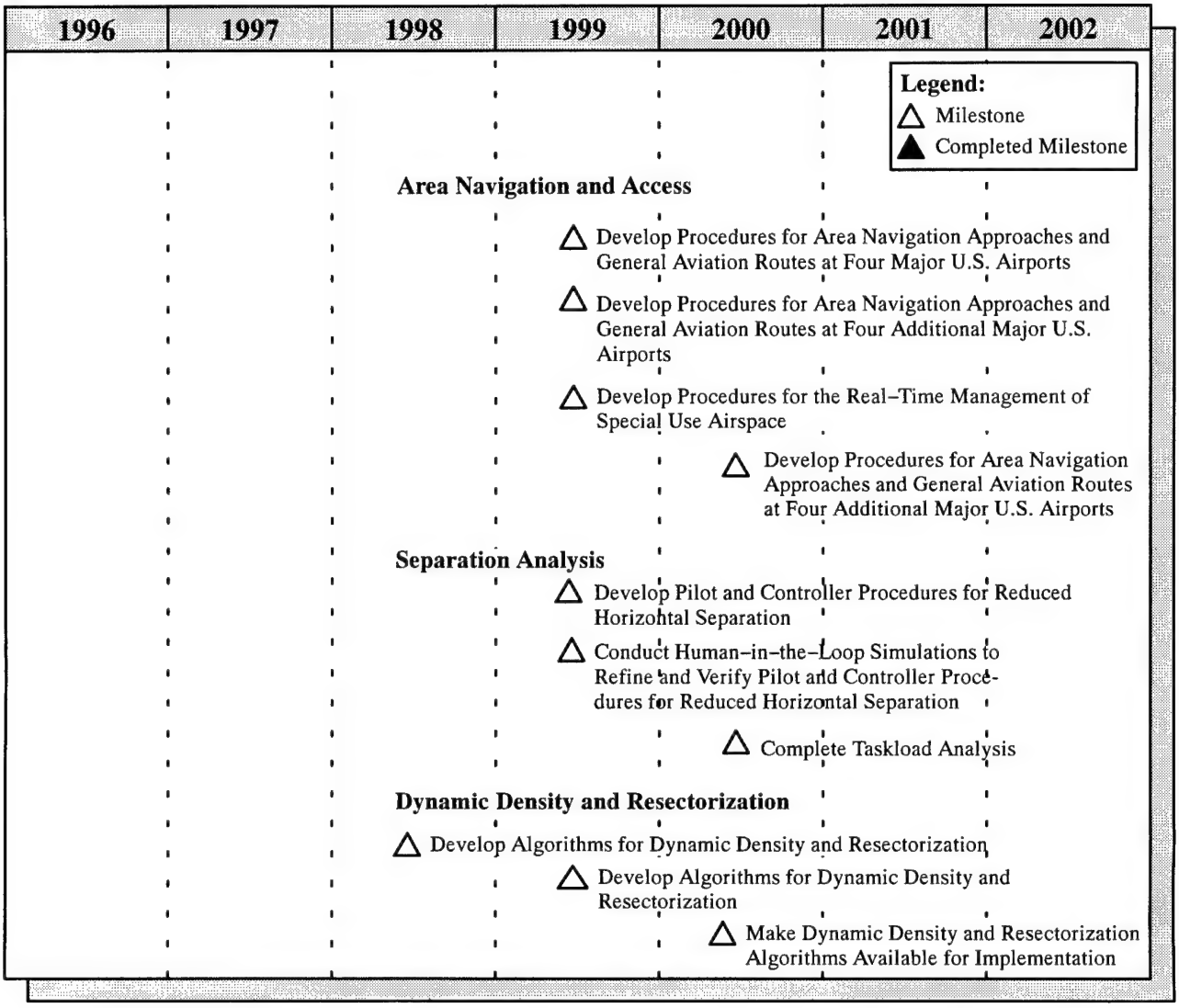
- New start in 1998.

Planned Activities: In 1999, procedures will be developed for area navigation approaches and general aviation routes at four major U.S. airports. Also in 1999, four additional U.S. airports will be investigated, and by 2000, 12 of the 38 major terminal areas will be investigated. Also in 1999, procedures for the real–time management of special use airspace will be developed.

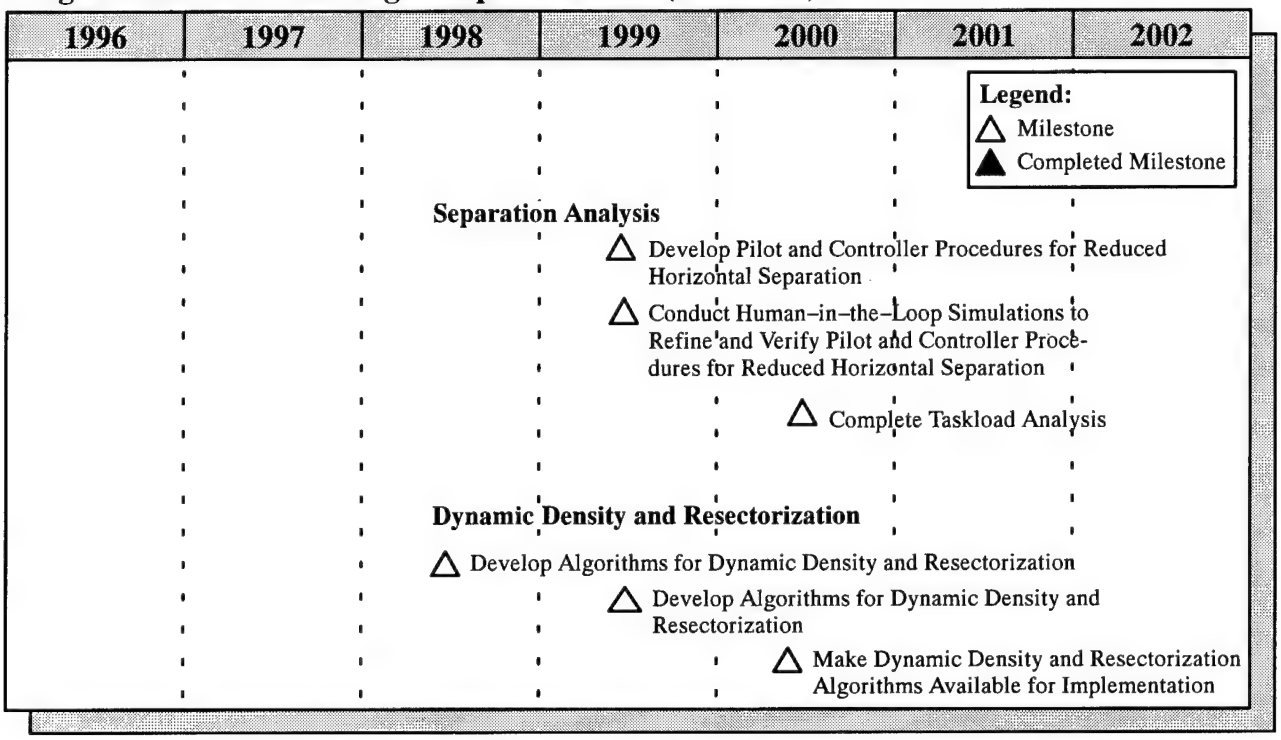
In 1999, pilot and controller procedures for reduced horizontal separation will be developed, and human–in–the–loop simulations will be conducted to refine and verify these procedures. In 2000, a taskload analysis will be completed.

In 1998–1999, algorithms for dynamic density and resectorization will be developed in conjunction with research into reduced separations. These algorithms will be made available for implementation in 2000.

Program 025–150: Free Flight Implementation



Program 025–150: Free Flight Implementation (continued)



3.0 COMMUNICATIONS, NAVIGATION, AND SURVEILLANCE

The air traffic management (ATM) system's ability to support safe and efficient future flight operations is critically dependent on a high-performance, reliable, cost-effective communications, navigation, and surveillance (CNS) infrastructure. Because these systems require avionics development and certification, the FAA takes an active role in assessing and defining system requirements, strengths, and characteristics for appropriate integration into the ATM system.

The sensor and computer technology to provide the desired CNS infrastructure is an extension of successful commercial and military developments during the 1980's. One key technology is a high capacity air mobile communication system that permits automated communications between the cockpit and the ground computer automation products being developed in Chapter 2. The International Civil Aviation Organization (ICAO) has recognized the need to develop international standards for this capability and has directed the Secondary Surveillance Radar Improvements and Collision Avoidance Systems Panel to include this standardization activity in its work program.

Another key technology is applying satellites to ATM. The satellite's role in future CNS systems has been highlighted by the Future Air Navigation System committee established by ICAO in 1983. The FAA has adopted the committee's recommendation as a basis for its CNS research program. This technology offers a number of opportunities to improve CNS coverage, accuracy, and reliability. Aircraft users are anticipating sufficient benefits and are aggressively planning to incorporate this technology in future airframe deliveries by developing appropriate interface standards. It is essential that the FAA proactively pursue this technology so that validated standards and certification criteria are available in a responsible timeframe. The research, engineering and development (R,E&D) challenge is to provide this CNS infrastructure by the mid-1990's for inclusion in the next generation aircraft.

Enhancements in CNS achieved through these R,E&D projects provide the basis for dramatic improvements in system performance including improved safety, reduced delay, increased capacity, and greater efficiency. These three functional areas represent key ATM infrastructure elements. For this reason, many of the quantitative benefits from this area will be realized by implementing projects in the capacity and ATM technology thrust area. For example, the Aeronautical Data Link project, the Satellite Communications project, and the Satellite Navigation project provide the technology necessary to achieve the benefits associated with reducing oceanic separation standards in the Oceanic Air Traffic Control (ATC) Automation program.

Several projects in this thrust area are focused on replacing, at the appropriate time, existing systems with systems that have enhanced capabilities. The future benefits assessment for these projects will only focus on the enhancements' value.

The Department of Defense's (DOD) global positioning system (GPS) deployment, justified by national security requirements, has many civilian applications. The DOD has stated that GPS will be available, at no direct cost, for civilian applications for the next 10 years. Some projects in this thrust area are developing applications based on GPS as the future primary air navigation system. The benefit from these projects will be the ability to forgo using the present very high frequency omnidirectional range (VOR)/distance measuring equipment (DME) network rather than replace the present electronic equipment. Furthermore, the ability to use differential GPS to provide near-category (CAT)-I landing capabilities could make this service available at virtually all airports.

SUMMARY

It is imperative that the FAA develop an aggressive and coordinated research program to exploit technological capabilities integrated into a safe and efficient ATM system that will satisfy future needs. The emerging CNS systems must be integrated with the automation and weather programs to achieve the safe and efficient ATM system that is required.

Table 3–1, Major Communications, Navigation, and Surveillance Products, provides a quick overview of major communications, navigation, and surveillance–enhancing products from R,E&D research efforts.

Table 3–1. Major Communications, Navigation, and Surveillance Products

Program Number	Program Name	Major Products
031–110	Aeronautical Data Link Communications and Applications	• United States and international ATN data communications, GPS squitter, and applications standards • Prototype systems and operational data link service evaluations • Testbeds for developing, evaluating, and demonstrating ATN and its subnetworks, ATC applications, and weather and aeronautical services
031–120	Satellite Communications Program	• International AMSS SARP's with ICAO • MOPS for AMSS avionics with RTCA • Integrated ATN/AMSS model capable of testing end-to-end data communications • Enhanced ATN AMSS model to include VHF digital link and Mode S subnetworks
031–130	NAS Telecommunications for the 21st Century	• National Institutes of Standards and Technology report certifying conformance or identifying areas of non–conformance with ISO standards • Minimum aviation signal performance standards and minimum operational performance standards (MOPS) for advanced air/ground communications systems • Standards and recommended practices (SARPs) for advanced air/ground communications systems
032–110	Satellite Navigation Program	• National satellite testbed • Satellite Navigation Center of Excellence • Satellite–based minimum operational performance standards
032–120	Navigation Systems Architecture	• Fault detection and exclusion algorithms for improved GPS receiver integrity monitoring • Strategy for decommissioning existing land–based navigation systems • Biennial Federal Radionavigation Plan publication

3.1 Communications, Navigation, And Surveillance Program Descriptions

* 031–110 Aeronautical Data Link Communications and Applications

Purpose: Efficient airspace use is constrained by communications limitations in the existing air traffic control system. As the key enabling technology for free flight, aeronautical data link, when combined with advanced ground and air automation systems, will permit evolution toward an advanced air traffic management system. The enhanced ATM communications capabilities provided by data link will facilitate improved airspace utilization, delay reduction, and operating expense reduction. This program has two major elements: Communications and Applications.

Approach:

Communications

This project will develop and validate domestic and international data communications standards associated with the Aeronautical Telecommunications Network (ATN) as well as special purpose air/ground data link capabilities such as the global positioning system squitter. The ATN will be used for both air/ground and ground/ground data communications, for the National Airspace System (NAS), and international aeronautical communications. This project will also provide the technical communications framework for all NAS systems that plan to implement data link services/applications.

Communications protocols for aviation use will be developed, validated, and standardized both nationally and internationally. ICAO is developing standards to permit the incremental development, validation, and implementation of the ATN and associated user applications. The initial standards will be for the first package of communications, navigation, and surveillance/air traffic management (CNS/ATM) capabilities. The standards associated with this CNS/ATM–1 package are currently being validated through international cooperative agreements and with industry participation. Domestic standards are being developed with RTCA and will be consistent with the ICAO standards for the CNS/ATM–1 package. ICAO will define subsequent packages at approximately two– to three–year intervals.

The aeronautical data link program is supporting government/industry development of ATN systems and certification tools through a cooperative agreement with ATN Systems, Inc.

A critical effort for this project is supporting the development of standards and investigating the use of the GPS squitter, a periodic data link broadcast from a mode select (Mode S) secondary radar transponder, for delivering GPS-based aircraft position reports. This automatic dependent surveillance broadcast (ADS–B) concept, when applied, will provide an enabling technology that supports surveillance of aircraft while airborne and on the airport surface. This technology is being used as the basis for enhancements to the traffic alert and collision avoidance system. Additionally, this technology may serve as a basis for future cockpit display of traffic information, as well as for terminal, en route, parallel runway monitoring, and airport surface air traffic control surveillance systems.

* *In 1998, this program will incorporate research from programs 022–150 Flight Operations and Air Traffic Management Integration and 031–120 Satellite Communications Program.*

Applications

Essential to achieving benefits from ground and airborne automation systems, data link applications must be developed as the key enabling technology to permit efficient flight crew to controller communications. This project will develop the operational concepts, software specifications, and computer/human interfaces to integrate data link ground and airborne automation systems into the NAS to support advanced air traffic management concepts, including free flight. The initial standards for applications will be incorporated in the ICAO standards for the CNS/ATM–1 package. ICAO will define subsequent packages at approximately two– to three–year intervals. Domestic standards are being developed with RTCA and will be consistent with the ICAO standards for the CNS/ATM–1 package.

Data link services in oceanic, en route, terminal, and tower environments are defined in coordination with the air traffic and aviation user communities. These services are being developed and evaluated by a team that includes air traffic controllers, pilots, and other system users as appropriate. Demonstrations will then be conducted with both ground and airborne system users to validate the overall operational system effectiveness.

Operational benefit assessments for initial and advanced data link applications will use high-fidelity ground and cockpit simulation facilities. The ATC services will be evaluated through preoperational trials at selected key sites with participating air carriers. Routine and hazardous weather applications will be demonstrated and evaluated in various simulation and airborne testbed facilities. Weather and aeronautical services such as traffic advisories, terminal weather information for pilots, and GPS squitter applications will be validated using this approach.

Related Projects: 021–140 Oceanic Air Traffic Automation, 022–110 Traffic Alert and Collision Avoidance System (TCAS), 022–140 General Aviation and Vertical Flight Program, 022–150 Flight Operations and Air Traffic Management Integration, 023–120 Separation Standards, 031–120 Satellite Communications Program, 031–130 NAS Telecommunications for the 21st Century, and 081–110 Flight Deck, Aircraft Maintenance, Flight Deck/ATC, System Integration Human Factors. Capital Investment Plan programs: A–01 En Route Automation Program, A–04 Standard Terminal Automation Replacement System (STARS), A–12 Airport Surface Target Identification System (ATIDS), C–20 Aeronautical Data-link, C–22 Gulf of Mexico, F–14 System Support Laboratory Sustained Support, F–15 General Support Laboratory Sustained Support, M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance, S–02 Mode S, W–03 Terminal Doppler Weather Radar (TDWR) System, and W–07 Integrated Terminal Weather System (ITWS).

University/Contractor Support:

- MITRE Corporation (CAASD)
  McLean, Virginia

- MIT Lincoln Laboratories
  Cambridge, Massachusetts

- Stanford Telecommunications
  Reston, Virginia

Products:

- United States and international ATN data communications, GPS squitter, and applications standards

- Operational concepts and specifications for production, automation, and communication systems that utilize/support data link

- Prototype systems and operational data link service evaluations

- Testbeds for developing, evaluating, and demonstrating ATN and its subnetworks, ATC applications, and weather and aeronautical services

- Test tools to support avionics certification

1996 Accomplishments:

Communications

- Completed initial validation of ICAO CNS/ATM–1 package standards and recommended practices (SARP's) through simulations, testbed evaluations, and limited FAA William J. Hughes Technical Center flight tests.

- Participated in North Atlantic unified trials in cooperation with air carriers and other civil aviation authorities leading to future operational evaluations of CNS/ATM–1 package.

- Completed generic specification for GPS squitter ground station.

Applications

- Developed functional specification for terminal ATC data link applications.

- Published operational concepts and minimum operational performance standards (MOPS) for advanced flight information services (FIS).

- Conducted operational demonstration for terminal weather information for pilots.

- Conducted operational demonstration of data link integration with center terminal radar approach control (TRACON) automation system (CTAS) and advanced automated en route air traffic control (AERA).

- Completed successful demonstration/evaluation of traffic information service, graphical weather service, and cockpit display of traffic information in cooperation with the general aviation community.

- Completed successful evaluation of GPS squitter for long range cockpit display of traffic information as needed to support free flight concepts.

1997 Projected Accomplishments:

Communications

- Complete and validate GPS squitter ICAO standard.

- Complete and validate RTCA standards for ADS–B.

- Define functions included in CNS/ATM–2 package.

- Conduct ATN interoperability tests with Eurocontrol, service providers, and airlines.

- Develop RTCA standards to align with ICAO CNS/ATM–1 package standards and required practices.

- Validate use of CNS/ATM–1 package to support NAS communications requirements.

Applications

- Complete RTCA standards for cockpit display of traffic information.

- Complete definition of operational requirements for CNS/ATM–2 package applications.

- Complete assessment of benefits to be derived from CNS/ATM–1 package.

- Support development of operational procedures and certification requirements for CNS/ATM–1 package applications.

Planned Activities:

Communications

Publication of ICAO CNS/ATM–1 package SARP's will occur in 1998. Also in 1998, the preoperational trials for CNS/ATM–1 will evolve to an initial operational capability in the North Atlantic. R,E&D activities will continue through 1999 to support developing and validating standards associated with the ICAO CNS/ATM–2 package. Also in 1998, ATN research, jointly sponsored by the FAA and ATN Systems, Inc. through a cooperative agreement, will produce prototype avionics and certification test tools. This effort will lead to a cooperative operational evaluation, including flight tests, that will begin in 1998. Also in 1998, very high frequency (VHF) data link will be validated to support standards approval in 1999. Between 2000–2002, research will be conducted to develop and apply standards for worldwide ATN operations as reflected in future ICAO CNS/ATM packages. Concept validation will take place by 2002. From 1998–2000, research will be conducted to define technically viable and cost–effective strategies for applying GPS squitter technology in high density terminals and to support free flight.

Applications

Publication of ICAO CNS/ATM–1 package SARP's will occur in 1998. Testbed evaluations for the production of CNS/ATM–1 package tower, terminal, and en route services will be completed in 1998. In 1999, data link will be fielded at key terminal and en route sites. R,E&D testbed tools will support national deployment of the CNS/ATM–1 package capability through 2002, and R,E&D testbed tools will be used on a continuing basis to support certification of avionics and airborne installations.

In 1998, research will begin on developing advanced terminal and en route data link services. User needs and procedural benefits analyses will take place through 1999, followed by specification development in 2000 and testbed evaluation of prototypes in 2001. Initial definition of surface data link services will be completed by 1998.

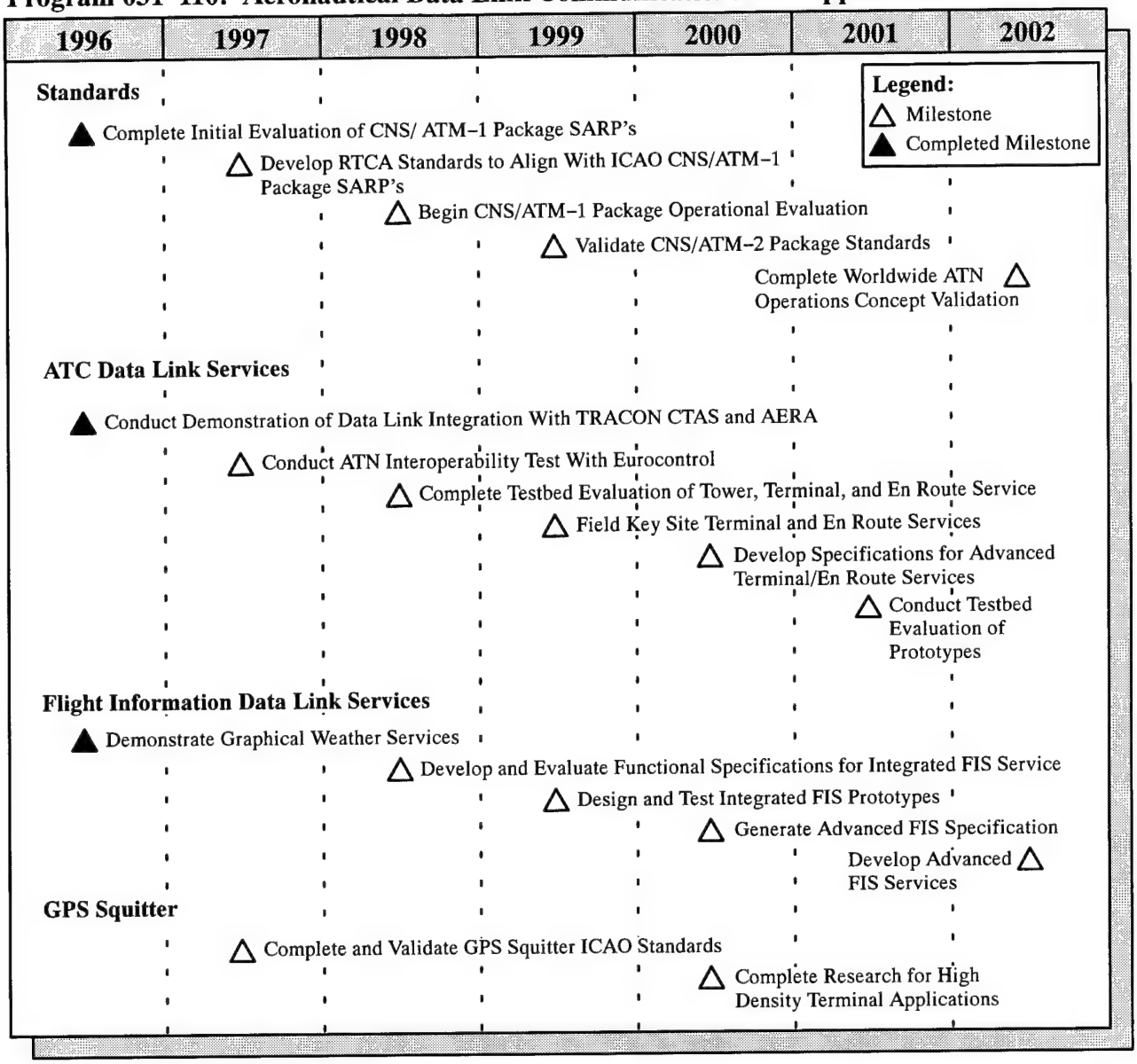
In 2001, research will begin on developing advanced automation data link enhancements. Commercial and general aviation experience with data link will be analyzed to produce next generation data link specifications.

In 1998, functional specifications will be developed and evaluated for the integrated FIS data link services. Prototypes will be designed and tested, and MOPS will be validated on FIS testbeds by 1999.

Research and development for the advanced flight information data link services will begin in 1999 with analyses of FAA and industry experiences with previously implemented FIS data links. The analyses results will be used to generate specifications in 2000 and prototypes/evaluation testbeds in 2001. Advanced FIS development work will be completed in 2002.

In coordination with FAA automation programs, research for FIS data link enhancements will begin after 2002.

Program 031–110: Aeronautical Data Link Communications and Applications



* 031–120 Satellite Communications Program

Purpose: The demand for oceanic airspace capacity is increasing due to an expected 50 percent traffic growth in the North Atlantic and 100 percent in the Pacific by 2000. Current communications are limited to high frequency (HF) voice radio only and are slow, unreliable, poor quality, and capacity constrained. Due to these technical constraints, real-time air traffic control cannot be accomplished in these regions, and transoceanic route capacity cannot be expanded

* *Will be combined with program 031–110 Aeronautical Data Link Communications and Applications in 1998.*

to accommodate the rapidly growing demand. This project will develop the standards and perform required testing to support mobile satellite communication (SATCOM) operational use as an oceanic subnetwork to the aeronautical telecommunications network. Further research will be conducted to extend these capabilities to domestic airspace.

Approach: Three separate R,E&D programs are working together to bring satellite data and voice communications capabilities to oceanic areas. This program is integrated with the Aeronautical Data Link Communications and Applications and the Oceanic Air Traffic Automation programs to achieve increased safety, help reduce separation standards, and provide direct, reliable communications in the oceanic and remote areas. Low earth orbit satellites (LEOS), medium earth orbit satellites (MEOS), and HF voice and data links will be evaluated as alternate subnetworks. Standards will be developed for the suitable subnetworks to provide complementary oceanic and remote communications networks. This program is separated into four distinct initiatives:

Developing SATCOM Data Capabilities for Oceanic and Remote Regions

The FAA will continue to support the international standards activities for implementing satellite data transmission in oceanic areas. Additionally, support will be provided to RTCA Special Committee 165 to develop MOPS and ensure that the MOPS are consistent with the SARP's.

Flight testing will be conducted to validate SARP's and MOPS with commercial airline participation over the North Atlantic in cooperation with European civil aviation authorities. A ground test facility will be used to conduct system end-to-end and radio frequency tests to validate standards not currently validated by manufacturers' data.

Developing SATCOM Voice Capabilities for Oceanic and Remote Regions

This initiative is necessary to provide satellite voice capability between the cockpit and the air route traffic control center (ARTCC) in oceanic flight information regions. In conjunction with RTCA, a guidance document will be produced describing the full range of technical requirements to provide satellite voice capability. In coordination with the oceanic project office, an architecture will be developed that will enable controllers to send and receive direct satellite voice communications. This effort includes developing appropriate interfaces for FAA equipment. Flight trials will be conducted with major airlines to demonstrate/evaluate satellite voice capabilities.

Implementing SATCOM Services in Oceanic and Remote Regions

This initiative addresses support for the Communications/Surveillance Operational Implementation Team (C/SOIT). This support includes technical expertise, analyses, and technical reports. The team is responsible for developing operational regulations and procedures that implement satellite voice and data communications. The benefits derived from SATCOM require a combined effort among ATN, ADS, ARTCC automation, and SATCOM. The C/SOIT ensures the joint implementation of these efforts. Technical data will be collected from bilateral and multilateral engineering trials. This effort will integrate real-time end-to-end communications and communication emulation capabilities into the Oceanic Development Facility.

Developing SATCOM Services for Selected Domestic Applications

The currently defined oceanic aeronautical mobile satellite services (AMSS) system may

have applications in domestic areas. For example, offshore or mountainous regions where very high frequency does not penetrate could benefit from AMSS service. It is also possible that emerging SATCOM technology, including possible low earth orbit or medium earth orbit systems, can provide reliable and efficient data/voice capability that meets domestic requirements at a reasonable cost. This program will conduct feasibility studies and evaluations on lower cost, lightweight satellite communications avionics for general aviation and rotorcraft. Additionally, analysis is underway to determine architecture requirements for future SATCOM use.

Related Projects: 021–140 Oceanic Air Traffic Automation, 022–140 General Aviation and Vertical Flight Program, 023–120 Separation Standards, 031–110 Aeronautical Data Link Communications and Applications, and 031–130 NAS Telecommunications for the 21st Century. Capital Investment Plan projects: A–10 Oceanic Automation Program (OAP), C–20 Aeronautical Data–link, C–24 Aeronautical Mobile Communications System – FAA Skylinks, and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Mayflower Communications Company, Inc. Billeria, Massachusetts

Products:

- International AMSS SARP's with ICAO
- MOPS for AMSS avionics with RTCA
- Integrated ATN/AMSS model capable of testing end-to-end data communications
- Enhanced ATN AMSS model to include VHF digital link and Mode S subnetworks

1996 Accomplishments:

- Published RTCA MOPS for SATCOM voice capability.
- Conducted engineering trials with United States Air Force on the "speckled trout" aircraft to collect high frequency data link propagation data.
- Completed architecture for SATCOM voice avionics.

1997 Projected Accomplishments:

- Conduct engineering trials with manufacturers' prototypes for satellite communications voice capabilities in oceanic and remote regions.
- Develop specifications and interface documents to support skylinks acquisition.
- Evaluate LEOS, MEOS, and HF voice and data links as alternate subnetworks.

Planned Activities:

<u>Developing SATCOM Data Capabilities for Oceanic and Remote Regions</u>

In 1999, ICAO AMSS MOPS and SARP's verification will be completed. Data collected during operational tests will be used in industry avionics bench testing for SARP's compliance certification and ICAO approval in 2001. The AMSS SARP's approval completes the R,E&D effort for this initiative.

<u>Implementing SATCOM Services in Oceanic and Remote Regions</u>

In 1999, data collection and analysis will continue from the North Atlantic engineering trials. Recommendations based on the data will be

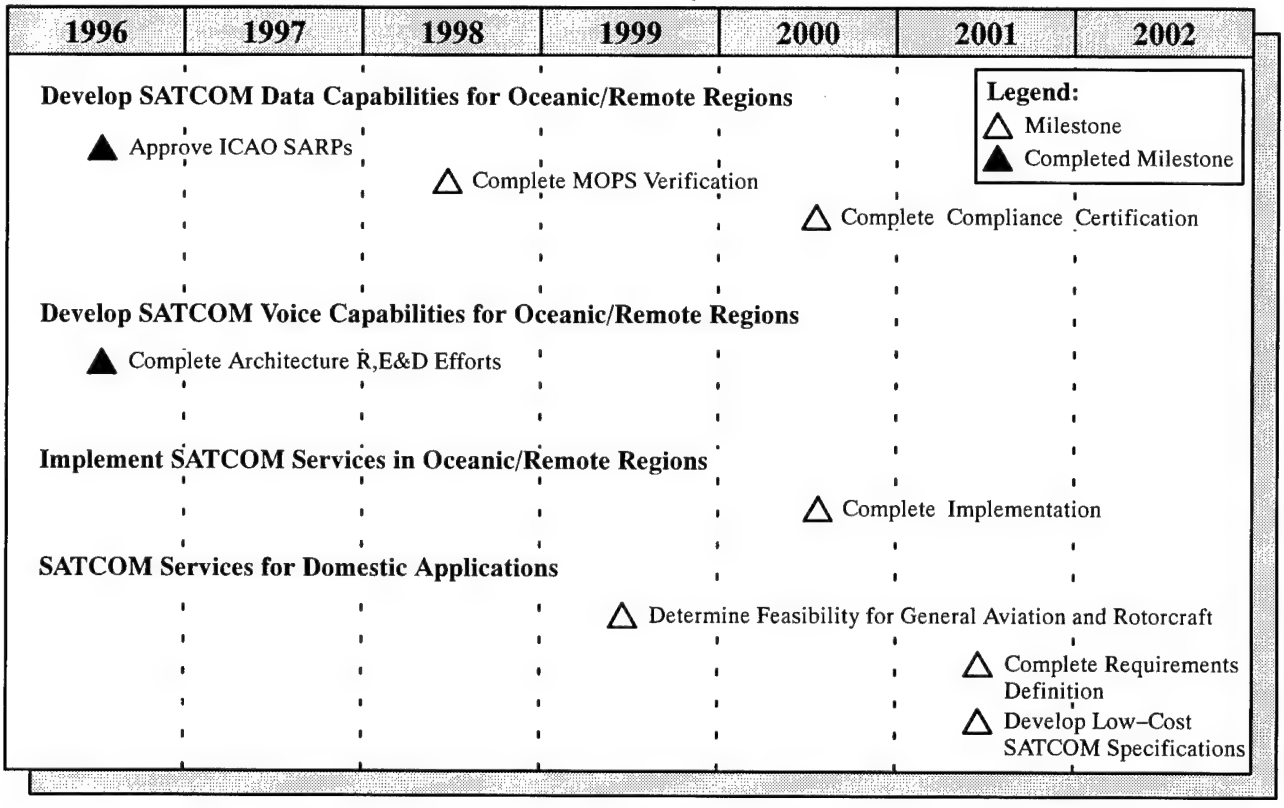
provided to the C/SOIT for regulatory and procedural implementation guidance. The C/SOIT plan specifies an incremental oceanic SATCOM implementation program that will be completed by 2000. Capital Investment Plan program C–24, Aeronautical Mobile Communications System – FAA Skylinks, is currently developing the necessary contractual vehicle to allow this program to convert from the R,E&D efforts to an operational environment.

Developing SATCOM Services for Selected Domestic Applications

In 1999, a feasibility determination will begin on lower cost, lightweight SATCOM avionics for general aviation and rotorcraft. From 1999–2001, a field evaluation using multiple, vendor-supplied prototypes will be conducted, leading to updated RTCA standards for commercial off-the-shelf low-cost SATCOM avionics.

In 1999, further research based on the alternative SATCOM technology requirements definition will continue on long-term alternatives for providing SATCOM service in domestic areas. Anticipated completion for this effort is expected in 2001.

Program 031–120: Satellite Communications Program



031–130 NAS Telecommunications for the 21st Century

Purpose: This program supports the next generation NAS communications system development by evaluating alternatives in new communication technology to satisfy future operational NAS requirements and goals. This effort is a multiyear program that is intended to speed the introduction of new technology into the NAS communications system. The current priority of this program is to ensure conformance of FAA–developed standards with the open systems interface model. Future efforts will examine communications technology such as low earth orbit satellites, middle earth orbit satellites, and wireless versions of commonly used personal communications systems (PCS).

Currently, a selected group of civil aviation telecommunication standards are not compatible with international standards of organization (ISO). As a result, the FAA is developing a set of standards to satisfy NAS aeronautical telecommunication requirements. This program will ensure conformance of those FAA–developed standards with the open systems interface model. These standards will enable the FAA to use commercial off–the–shelf products.

Currently, the capital cost to replace the air/ground communications infrastructure is about $1 billion, and annual operating costs exceed $100 million. New communication technologies, such as LEOS, MEOS, and PCS promise to reduce costs substantially. The advanced air/ground communications architecture research will determine the architecture for air/ground communications in the era beyond the currently planned system. The effort will emphasize use of standard communications services to the greatest extent possible.

Approach:

Open Systems Interface Standards

Research in this area will utilize National Institutes of Standards and Technology expertise and capabilities in the open system interface standards and protocols to assure FAA compliance with international standards as well as to keep abreast of the latest developments in open system services.

Advanced Air/Ground Communications Architectures

This research effort will address new communications technology developments such as LEOS, MEOS, and PCS in national and international forums in cooperation with service providers (Iridium, AMSC, and Inmarsat), industry, air carriers, and other users to determine the viability of such systems to replace currently planned air/ground communication systems.

Related Projects: 031–110 Aeronautical Data Link Communications and Applications, and 031–120 Satellite Communications Program. Capital Investment Plan programs: M–15 National Airspace System Spectrum Engineering Management.

University/Contractor Support:

- National Institute of Standards and Technology
  Bethesda, Maryland
- MITRE Corporation
  McLean, Virginia
- Stanford Telecommunications
  Reston, Virginia

Products:

- National Institutes of Standards and Technology report certifying conformance or identifying areas of non–conformance with ISO standards
- Market survey of available communications resources for advanced air/ground communications systems
- Minimum aviation signal performance standards and minimum operational performance standards (MOPS) for advanced air/ground communications systems
- Standards and recommended practices for advanced air/ground communications systems

1996 Accomplishments:

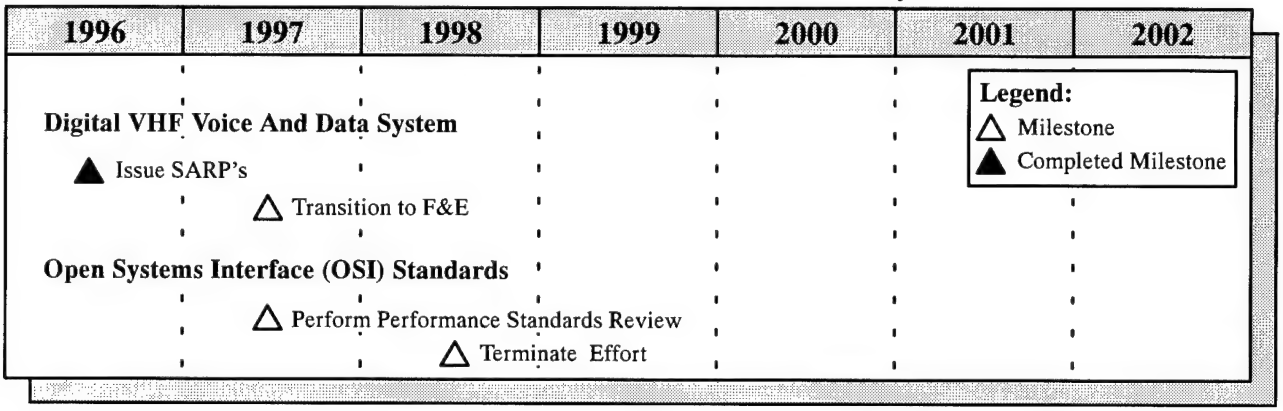
- Issued draft digital VHF voice and data SARP's.
- Transitioned VHF initiative to F&E.

1997 Projected Accomplishments:

- Complete conformance testing of an FAA data link standard.

Planned Activities: Due to budget constraints and higher priorities, this project has been deferred or cancelled indefinitely in FY 1998 and beyond.

Program 031–130: NAS Telecommunications for the 21st Century



032–110 Satellite Navigation Program

Purpose: This program will develop augmentations to navigation satellites (e.g., the global positioning system) to support techniques, procedures, and standards to meet all civil aviation navigation needs using a single navigation receiver. Civil aviation navigation needs include oceanic, en route, and terminal navigation as well as non-precision approach, precision approach, auto-landing, and airport surface navigation. Satellite navigation presents opportunities for standardized worldwide civil aviation operations using a common navigation receiver and for significant improvements in safety, capacity, service flexibility, and operating costs. Adopting satellite navigation systems could lead to phasing out existing National Airspace System ground

equipment while maintaining or improving existing service levels. In addition, satellite-based navigation systems provide the potential for new navigation and landing services not currently supported by existing systems.

Approach: This program will focus on developing standards, procedures, and methods to use the global positioning system to meet civil aviation requirements. Research activities include the development and acquisition of prototype GPS augmentation techniques such as the wide area and local area systems, development of a national satellite testbed, and the establishment of a national satellite system control capability. Program activities will investigate, research, develop, and acquire GPS augmentations for required navigation performance (RNP) for en route, airport surface, terminal, departure, non-precision, and precision approaches. All satellite navigation signals, ionospheric interferences, timing procedures, satellite ephemeris anomalies, and any other factors that impact user accuracy, integrity, availability, and continuity of service will be addressed and corrective actions determined. The research and development will be evaluated through practical concept evaluation, studies, analyses, and flight trials/demonstrations utilizing the national satellite testbed.

The basis for determining future improvements will come from the evaluation of data collected by the Satellite Navigation Center of Excellence which will monitor satellite activity, wide area augmentation system (WAAS)/local area augmentation system (LAAS) status, and user message information. The Satellite Navigation Center of Excellence will collate, coordinate, and direct all research and development activities which will determine WAAS option requirements definition, LAAS system requirements, and potential future system upgrades. The overall program will be directed by the Satellite Navigation Program office with support from the FAA William J. Hughes Technical Center.

The Satellite Navigation Program is structured to support an integrated program team approach through four interrelated and complementary thrusts. These thrusts will focus on civil aviation service, operational implementation of the service, international activities to gain support and development of a seamless global navigation satellite system, and national airspace system interface applications.

Related Projects: 021–140 Oceanic Air Traffic Automation, 022–140 General Aviation and General Flight Program, 023–120 Separation Standards, and 032–120 Navigation Systems Architecture. Capital Investment Plan programs: A–01 En Route Automation Program, A–02 Tower Automation Program, A–04 Standard Terminal Automated Radar System (STARS), A–10 Oceanic Automation Program (OAP), A–14 Instrument Approach Procedures Automation (IAPA), C–20 Aeronautical Data–Link, C–21 Next Generation Air/Ground Communications System, F–15 General Support Laboratory Sustained Support, M–07 National Infrastructure Management System (NIMS), M–15 National Airspace System Spectrum Engineering Management, N–03 Instrument Landing System, N–08 Runway Visual Range (RVR), and N–12 Augmentations for the Global Positioning System (GPS).

University/Contractor Support:

- Stanford University
  Palo Alto, California
- Ohio University
  Athens, Ohio
- Advanced Management Technology, Inc.
  Washington, D.C.
- Stanford Telecommunications
  Reston, Virginia

- Innovative Solutions International, Inc. Tysons Corner, Virginia

Products:

- Wide area augmentation system
- Local area augmentation system
- National satellite testbed
- Satellite Navigation Center of Excellence
- Satellite–based approach procedures
- Satellite–based minimum operational performance standards
- Satellite–based technical standard orders
- Special category I minimum aviation system performance standards

1996 Accomplishments:

- Completed national satellite testbed hardware upgrades and software algorithm definition.
- Completed initial LAAS architecture definition and integrity methodology.
- Completed technical standard order and minimum operational performance standards for WAAS non–precision approaches.

1997 Projected Accomplishments:

- Complete national satellite testbed software algorithms.
- Complete national satellite testbed integration and test, and provide test signal in space.
- Complete Satellite Navigation Center of Excellence.
- Complete environmental simulator.
- Develop LAAS minimum operating performance standards.

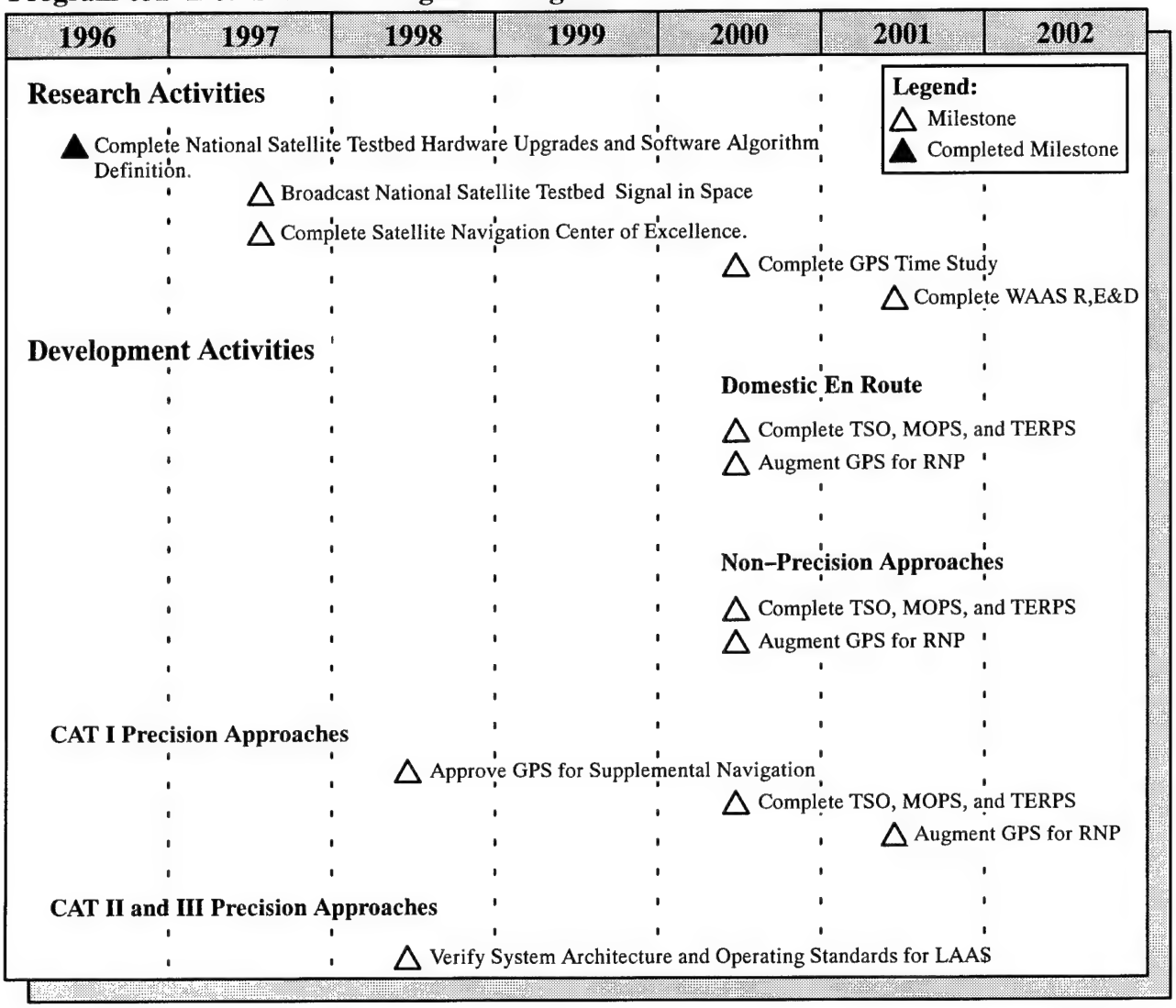
Planned Activities: In 1998, research will continue on developing standards and operational procedures to permit early satellite navigation system implementation for civil aviation. Also in 1998, research and development activities will include conducting aviation flight trials for GPS–instrumented aircraft operations. In 2000, improvements in GPS time transfer will be completed. Improved accuracy availability, integrity, and continuity of service will be provided by the completion of the WAAS in 2001.

Continuing in 1998, research will investigate the control and operation of U.S. navigation satellites. Procedures and orders to support the above concepts will be developed, culminating in technical standard orders, minimum operational performance standards, and terminal instrument procedures (TERPS) in 2000 for en route through CAT I precision approaches.

GPS supplemental precision approaches to CAT I will be approved for public use in 1998, with RNP scheduled for 2001. In 2000, GPS augmented for RNP will be implemented in domestic en route airspace.

In 1998, the LAAS system architecture and operating standards will be verified and validated to transition this technology to industry for production.

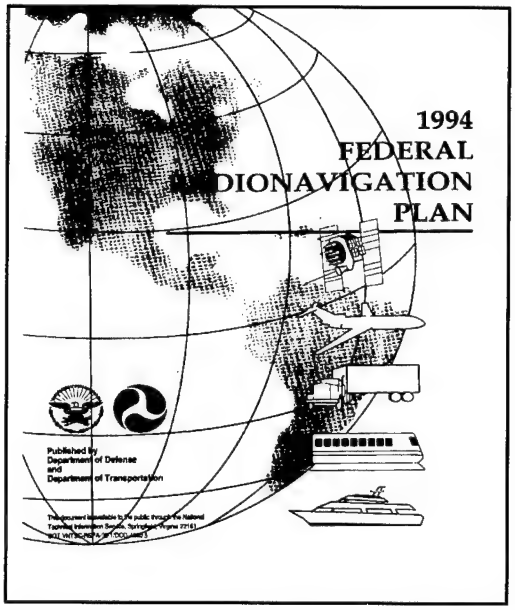
Program 032–110: Satellite Navigation Program



032–120 Navigation Systems Architecture

Purpose: The FAA has the responsibility for developing and implementing radionavigation systems to meet the needs of all civil and military aviation, except those peculiar to air warfare. This program, in an integrated effort with other R,E&D programs, addresses transitioning to a satellite-based navigation system and developing the strategy for decommissioning older-technology ground-based systems. An important aspect is identifying and evaluating emerging technologies and new concepts for meeting future navigation service requirements.

Navigation Systems Architecture also supports the Federal Radionavigation Plan biennial revision and provides the FAA input to the joint Department of Transportation and Department of Defense Positioning and Navigation Working Group.



1994 Federal Radionavigation Plan

Approach: This program's emphasis is to support developing a NAS transition strategy that will provide guidance for a major shift to satellite technology. Research will focus on resolving three major issues: current navigation system supportability; transition to satellite-based navigation; and potential ground-based system phase-out.

Until a transition to satellite systems is completed, research will continue on phase–out strategies for current ground-based systems. Available technology will also be examined for the potential to enhance the GPS signal, if required.

Studies will be conducted to facilitate the transition to satellite navigation. Results will be validated in laboratory simulations to test their effectiveness. Research will focus on developing and validating advanced fault detection and exclusion algorithms to improve GPS receiver integrity monitoring in aircraft avionics and developing advanced GPS availability notification capabilities.

Studies and analyses will be performed to help complete development of the required navigation performance concept for satellite-based approach and landing operations. The results from these efforts will help determine the specific required navigation performance parameters to be applied. Recommendations will be provided to the ICAO All Weather Operations and Global Navigation Satellite System panels, the FAA Satellite Operational Implementation Team, and RTCA special committees for incorporation into appropriate standards.

Supplemental studies and analyses will be performed to support NAS planning and Federal Radionavigation Plan development. Based on the research results, recommendations will be made on the mixture of navigation systems required to support NAS operations. A national aviation standard will be developed and maintained for each system approved for use in the NAS.

Related Projects: 032–110 Satellite Navigation Program. Capital Investment Plan programs: M–03 System Engineering and Technical Support, N–03 Instrument Landing System (ILS), N–06 VORTAC, N–09 Sustain Distance Measuring Equipment (DME), N–10 Sustain Nondirectional Beacon (NDB), N–11 Loran–C Monitors and Transmitter Enhancements, and N–12 Augmentations for the Global Positioning System (GPS).

University/Contractor Support:

- Volpe National Transportation Systems Center
  Cambridge, Massachusetts

- Stanford Telecommunications
  Reston, Virginia

- AMTECH/Deering Systems Design Consultants
  Deering, New Hampshire

- Ohio University
  Athens, Ohio

Products:

- Fault detection and exclusion algorithms for improved GPS receiver integrity monitoring
- Advanced GPS availability notification capabilities
- National aviation standards for radionavigation systems
- Strategy for decommissioning existing land–based navigation systems
- Recommendation for the NAS radionavigation system mixture
- Biennial Federal Radionavigation Plan publication

1996 Accomplishments:

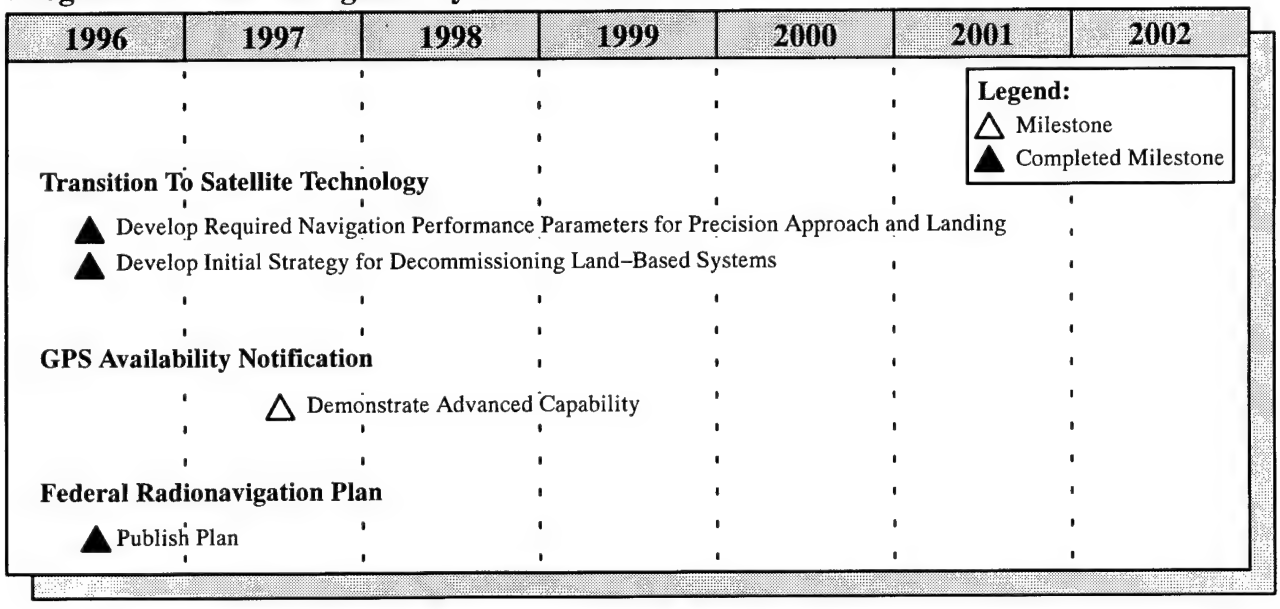
- Developed required navigation performance parameters for precision approach and landing.
- Developed fault detection and exclusion algorithms for improved GPS receiver integrity monitoring.
- Published the 1996 Federal Radionavigation Plan.
- Developed initial strategy for decommissioning existing land–based navigation systems.

1997 Projected Accomplishments:

- Demonstrate advanced GPS availability notification capability.
- Develop operational requirements for advanced surface movement guidance and control systems.
- Develop minimum operational performance specifications for GPS local area augmentation system, including development of radio frequency interference susceptibility filter.

Planned Activities: Due to budget constraints and higher priorities, this project has been deferred or cancelled indefinitely in FY 1998 and beyond.

Program 032–120: Navigation Systems Architecture



4.0 WEATHER

Weather is, and will continue to be, a critical factor in all flight operations. It is the single largest contributor to delays and a major factor in aircraft accidents and incidents. Improved weather forecasts offer the potential for increasing system capacity more cost effectively than most other alternatives, such as new airports and runways. Better short-term forecasts and current information on hazardous weather conditions are critical to ensuring safe flight. Also, timely and accurate weather information is critical to planning fuel- and time-efficient flight plans. Weather service users encompass the entire aviation spectrum, from the student pilot to the operator of the most sophisticated, high-performance commercial aircraft during all flight phases.

The future air traffic management (ATM) system will require highly accurate real-time weather warning products and short- and long-term weather forecasts, covering the time period from a few minutes, up to 3, 6, and even 12 hours into the future. Progress in weather research necessary to develop these products, and to implement a system infrastructure to deliver enhanced weather products to end-users, will be critical to addressing this need.

The aviation weather thrust area includes a combination of Research, Engineering and Development (R,E&D) weather projects and new Capital Investment Plan (CIP) weather initiatives that will build upon ongoing weather system development to realize the full user benefits. Both components are critical to the overall success of the weather system modernization effort.

AVIATION WEATHER MISSION NEEDS

Good flight planning is necessary for all flight operations. A principal need is the capability to provide weather information to support hazardous weather avoidance. In a planning sense, the aviator needs to have good forecast information to avoid hazards in flight.

Efficiency is determined by minimizing time in flight or fuel used. Flight efficiency to a large degree implies the capability for economic or pilot-chosen routing. This capability implies a significant need for timely and accurate strategic weather information during flight planning so that a route can be selected to minimize the need for dynamic rerouting during flight.

In the terminal area, predicting significant wind shifts is needed to optimize runway management. In addition, more accurate wind field analyses will provide terminal air traffic automation systems with optimal descent profiles. Enhanced hazardous weather depiction will mitigate weather impacts on arrival and departure corridors. Improved windshear warnings, microburst detection, thunderstorm predictions, and other products will be particularly important in this regard.

Finally, with the increase in oceanic traffic, and in close connection with oceanic air traffic control, there is a need to establish oceanic weather warning and forecast centers that can provide timely weather information. Improved weather information will provide route flexibility commensurate with systems such as automatic dependent surveillance and will enhance transoceanic flight safety.

Table 4–1, Major Weather Products, provides a quick overview of major weather–enhancing products from R,E&D research efforts.

Table 4–1. Major Weather Products

Program Number	Program Name	Major Products
041–110	Aviation Weather Analysis and Forecasting	• Precise and usable algorithms and/or numerical models related to icing, turbulence, convective initiation, visibility, ceiling, and snowstorm forecasting • New mesoscale numerical data assimilation and prediction models adapted to aviation needs and new methods for nowcasting • Automated techniques for detecting, quantifying, and forecasting meteorological events
042–110	Aeronautical Hazards Research	• Advisory circular on hazardous mountain winds and their visual indicators • Hazards definition • Guidance for flight operations

4.1 Weather Program Descriptions

041–110 Aviation Weather Analysis and Forecasting

Purpose: This program will enhance the basic understanding of weather as it affects aviation. Since weather impacts on the National Airspace System are spatially small (mesoscale), this program will be integrated with other national research program activities that focus on the atmospheric mesoscale analysis and prediction problem. A further purpose is to concentrate research efforts on developing new algorithms, numerical weather analysis and prediction models, and methods to detect/predict the impact from weather hazards. This research will significantly improve weather product and forecast quality, thus enabling aviation weather users to make effective strategic and tactical decisions for aviation operations.

This program will also develop a specialized airborne humidity sensor to meet unique, critical aviation weather requirements for 3-dimensional moisture data. Ground-based sensors alone cannot provide the 3-dimensional information needed to create accurate icing and visibility forecast products. This airborne sensor will provide new moisture data for icing forecasts in the terminal and en route airspace.

Approach: This program includes four major components: (1) participating in interagency activities to better understand aviation weather phenomena; (2) developing models and algorithms for generating nowcast and short-term aviation-specific products; (3) developing and testing algorithms for the WSR–88D next generation weather radar (NEXRAD) product improvements; and (4) developing an airborne humidity sensor. Product areas include icing forecasts; en route and transition turbulence, ceiling, and visibility; thunderstorm and microburst prediction; and wind analysis and forecasting.

The objectives in the weather R,E&D program are incorporated in the stated goals of the U.S. Weather Research Program (USWRP), which is a congressionally mandated interagency program under the lead of the National Oceanic and Atmospheric Administration. The FAA will participate in the USWRP to address regional and local scale weather phenomena that are unique to aviation. The USWRP's strategic priorities of most interest to the FAA are to "improve local and regional weather forecasts" and to "achieve efficiencies by coordinating efforts of federal agencies, state institutions, the academic research community, and the private sector." Involvement in the USWRP will benefit a significant portion of the R,E&D program.

The major objective for icing forecasting improvements is to develop an aircraft icing forecast capability. This capability will provide accurate delineation of actual and expected icing areas by location, altitude, duration, and potential severity. Another element in the icing program is to create a capability to forecast the onset, intensity, and cessation of structural icing on the ground to support anti-icing activities.

Detecting and avoiding clear air turbulence can improve NAS safety and capacity. This research effort will develop a model for short-term en route and transition turbulence forecasting using wind, temperature, and moisture data. A variety of models will be developed and applied to forecasting wind flow patterns, downbursts, wind direction changes, windshear, and gust fronts for the lower atmosphere.

This research and development program is being coordinated with and accomplished through interagency agreements with the National Science Foundation and the National Oceanic and Atmospheric Administration. The Aviation

Weather Analysis and Forecasting program will provide current analyses, nowcasts, and short-range predictions of relevant atmospheric fields and hazardous weather phenomena. Products derived from the above information will be tested and evaluated at the Aviation Weather Development Laboratory in Boulder, Colorado, and the National Weather Service's Aviation Weather Center at Kansas City, Missouri, to facilitate transition of appropriate products to operational aviation weather services and industry through cooperative research and development agreements.

Related Projects: 042–110 Aeronautical Hazards Research and 064–110 Flight Safety/Atmospheric Hazards. Capital Investment Plan programs: M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance, W–04 Weather and Radar Processor (WARP), and W–07 Integrated Terminal Weather System (ITWS).

University/Contractor Support:

- Oklahoma University
  Norman, Oklahoma
- Pennsylvania State University
  State College, Pennsylvania

Products:

- Precise and usable algorithms and/or numerical models related to icing, turbulence, convective initiation, visibility, ceiling, and snowstorm forecasting
- New mesoscale numerical data assimilation and prediction models adapted to aviation needs and new methods for nowcasting
- Automated techniques for detecting, quantifying, and forecasting meteorological events
- Prototype airborne humidity sensor

1996 Accomplishments:

- Enabled the Aviation Weather Center to issue the first ever forecast of freezing precipitation aloft.
- Operated Chicago testbed providing weather information for ground deicing decisionmaking to United, American, and the City of Chicago.
- Performed storm growth and decay experiment in Memphis.
- Commenced aviation gridded forecast system (AGFS) demonstration at the Aviation Weather Center.
- Completed upgrades to storm cell identification and tracking, and hail detection algorithms for inclusion into NEXRAD.
- Initiated flight testing of airborne humidity sensor.

1997 Projected Accomplishments:

- Conduct inflight icing algorithm evaluation at AWC.
- Complete inflight data evaluation of turbulence algorithm.
- Complete AGFS demonstration at the Aviation Weather Center.
- Operate testbed providing weather information for ground deicing decisionmaking to the Port Authority of New York and one of the New York area airports.
- Conduct storm growth and decay experiment in Orlando and Dallas–Ft. Worth.
- Demonstrate and flight certify airborne humidity sensor.

- Complete upgrades to mesocyclone and tornado detection algorithms for NEXRAD.

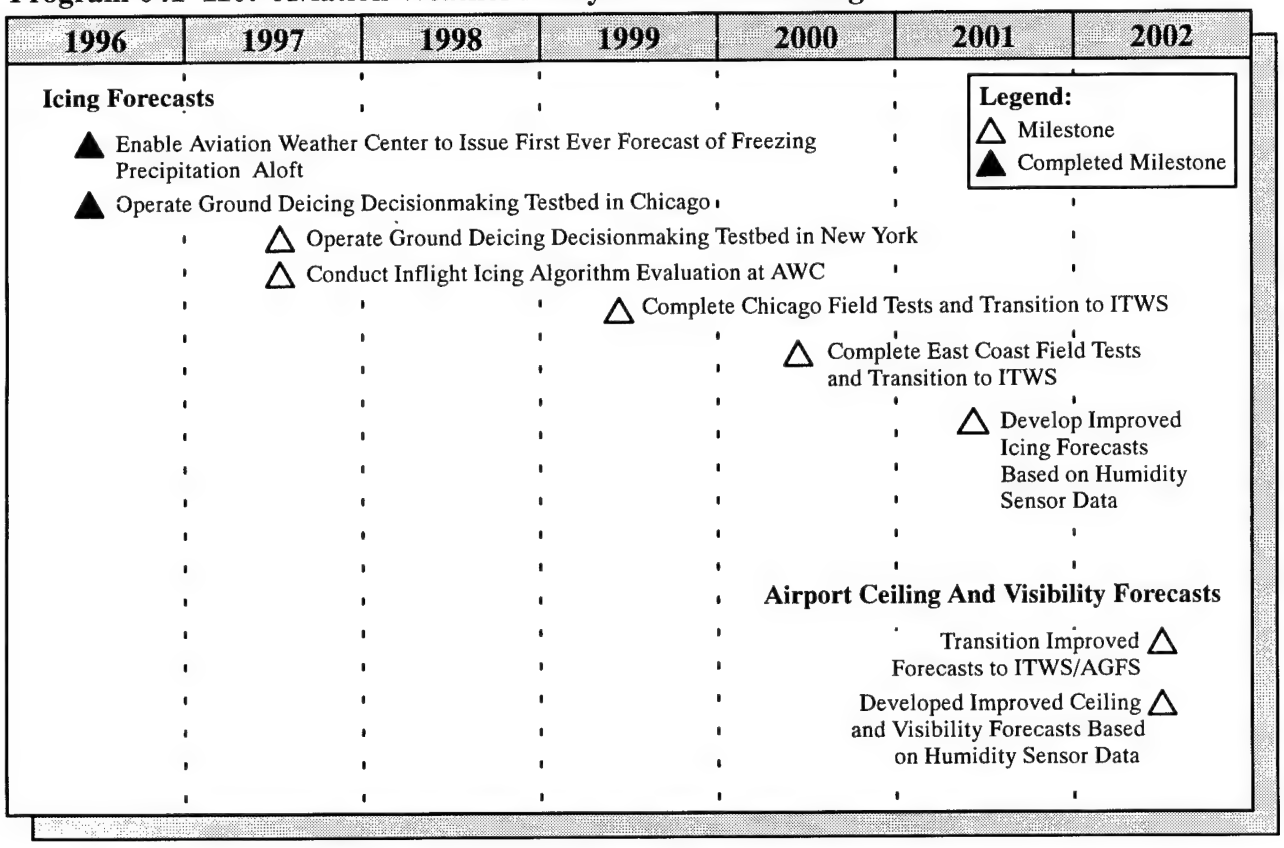
Planned Activities: In 1999, improved thunderstorm autonowcast algorithms will be evaluated at Memphis, Dallas–Ft. Worth, and Orlando. During the winter ending in March 1998, icing forecast technique field tests will be conducted in Chicago; the results will transition to the integrated terminal weather system (ITWS) in 1999. The east coast field test will run from 1998–1999, and the algorithms will transition to the ITWS in 2000. Improvements in icing forecasts will continue through 2001 by using the high resolution humidity data available from the airborne humidity sensor.

In 1999, research will continue on automating changes in ceiling and visibility forecasts at airports, with improved forecasts transitioning to the ITWS and the national aviation gridded forecast system in 2002. Further improvements will be developed after 2002 using the high resolution humidity data from the airborne humidity sensor. Turbulence forecast improvements will be developed between 1999 and 2002. Improved runway wind forecasts will be developed beginning in 2002. Turbulence and runway winds forecasts will transition to AGFS and ITWS respectively.

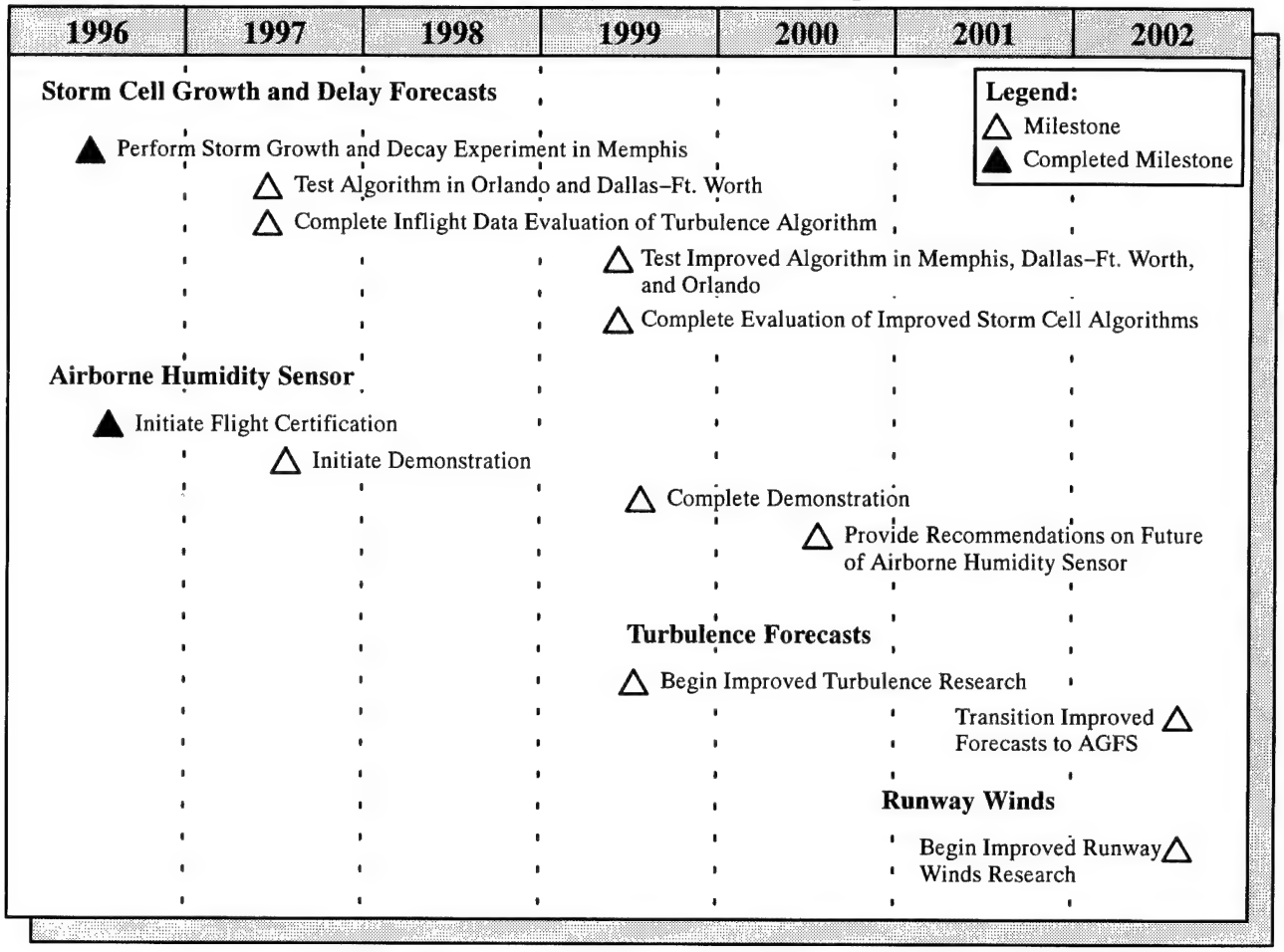
In 1999, the demonstration of the utility of airborne humidity sensing will be completed. Recommendations on the future of airborne humidity sensing will be made in 2000.

This program is coordinated with the Aeronautical Hazards Research program to provide scientific meteorological expertise on mountain rotor.

Program 041–110: Aviation Weather Analysis and Forecasting



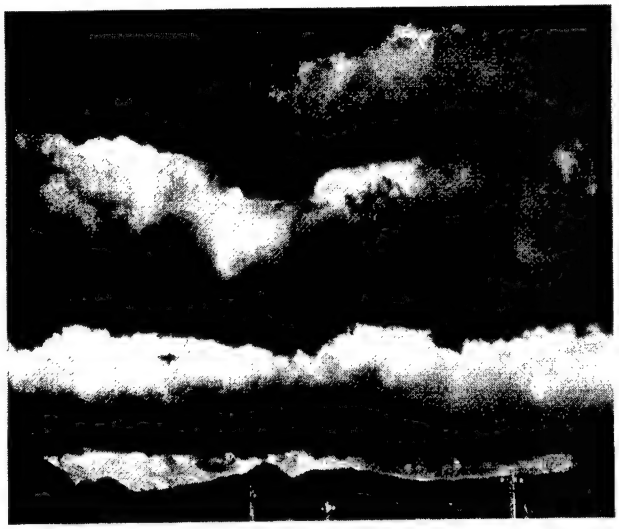
Program 041–110: Aviation Weather Analysis and Forecasting (continued)



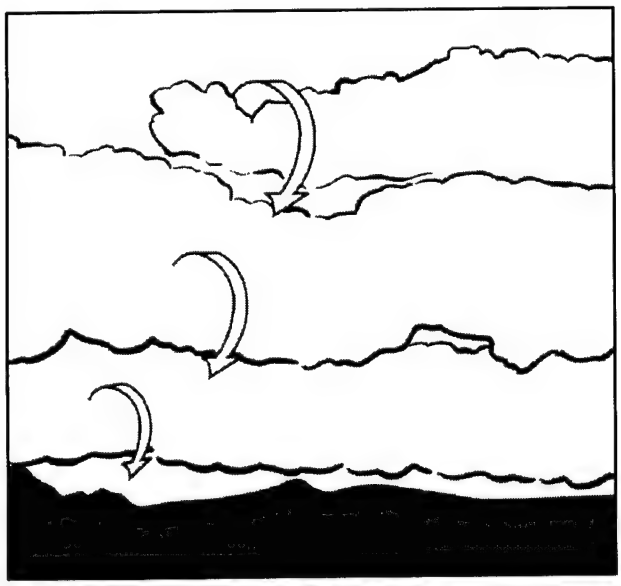
042–110 Aeronautical Hazards Research

Purpose: This program is designed to improve safety by responding to specific National Transportation Safety Board recommendations on aeronautical hazards. Mountain wave aeronautical hazards, such as mountain rotors, are suspected factors in weather related accidents/incidents. This program will collect data and analyze systems to validate technology for predicting and detecting hazards. This research will provide an improved operational capability to detect, monitor, and alert flightcrews to aeronautical hazards.

Approach: Following the Colorado Springs air carrier accident in 1991, the National Transportation Safety Board recommended that the FAA develop and implement a meteorological program to observe, document, and analyze aircraft hazards in mountainous areas with a focus on approach and departure paths. This program will study mountain wave phenomena to develop procedures and technology for detecting and avoiding these hazards. Initial research will be conducted to define the hazards and collect data on mountain rotors.



Vertically Enhanced Rotor Clouds Associated With a Trapped Lee Wave at Boulder, Colorado (Photograph Copyright, 1992, P. Neiman)



The energy visible in these clouds often exists in the absence of clouds, making this mountain-induced hazard invisible.

An important element in this program is leveraging research from the Wake–Vortex Separation Standards program to aid in the detection and avoidance of mountain wave hazards. Certain similarities between the mountain wave and wake–vortex hazards provide an opportunity to integrate research in a collaborative effort. However, sensor technology gained from the wake–vortex program will need to undergo development work to make it applicable for detecting mountain wave hazards.

Related Projects: 021–230 Wake–Vortex Separation Standards and 041–110 Aviation Weather Analysis and Forecasting. Capital Investment Plan programs: M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support: None.

Products:

- Hazards definition
- Advisory circular on hazardous mountain winds and their visual indicators
- Improved modeling and predictive techniques
- Guidance for flight operations

1996 Accomplishments:

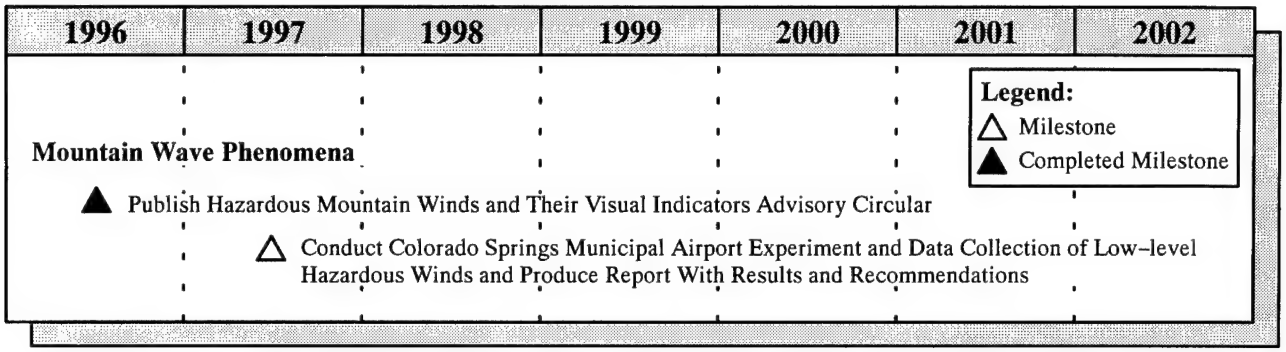
- Published joint FAA/National Oceanic and Atmospheric Administration (NOAA) Hazardous Mountain Winds and Their Visual Indicators advisory circular.

1997 Projected Accomplishments:

- Conduct Colorado Springs Municipal Airport experiment and data collection of low–level hazardous winds and produce report with results and recommendations.

Planned Activities: Due to budget constraints and higher priorities, this project has been deferred or cancelled indefinitely in FY 1998 and beyond.

Program 042–110: Aeronautical Hazards Research



5.0 AIRPORT TECHNOLOGY

The FAA is responsible for fostering safe and efficient national airport system development. The Airport Technology Research and Development Program assists in developing new and improved standards and criteria to plan, design, construct, operate, and maintain the Nation's airports, heliports, and vertiports.

There are over 18,000 aircraft landing areas in the United States. Aircraft are increasing not only in number, but more importantly, in weight, landing speed, and overall dimensions. Many airport facilities are reaching design life, and the capital costs of airport improvements over the next 5 years are estimated to exceed $30 billion. Research is an important factor in the efforts to control costs. Both passenger enplanements and aircraft operations are projected to experience strong growth for the foreseeable future, leading to airport activity levels two or more times greater than today. However, the possibilities for expanding existing airports or building new airports are limited. Consequently, maximum benefits must be derived by maintaining and improving existing facilities and by supporting research that can reduce congestion and delays at airports. Research can also provide innovative means for improving safety, increasing capacity, improving airport access and passenger services, assessing federal investment effectiveness, and supporting U.S.–developed aviation products.

Airport technology research can lead to improved designs, techniques, equipment, and methods to assess system performance that will increase federal investment effectiveness of the $1.5 billion Airport Improvement program as well as the even greater investments in infrastructure made by the owners and users of the airport. For example: pavement and other facility life-cycle costs can be reduced; capacity can be improved and delays reduced; and both airports and heliports can be better integrated into the National Transportation System.

Pavement research has the potential for very large benefits. Approximately $2 billion is spent on constructing, rehabilitating, and maintaining airport pavements each year, whereas only $3 million is spent on research. Increasing the average life of pavements by as little as 10 percent through research would result in a cost/benefit ratio of 50 to 1 or more. This objective is not unreasonable or unattainable.

Continued research in visual guidance systems is necessary to enhance ground operations at night or under low visibility conditions. Pilots and vehicle operators must receive clear and unambiguous information from lights, signs, and markings. Improvement in this area will help eliminate runway incursions. State–of–the–art light sources and applications are necessary. These improvements include fiber optics, laser sources, holographic techniques, and advanced "control" systems.

Improved traction on airport surfaces remains a critical safety concern especially during winter operations. Loss of control while braking and maneuvering has led to a number of tragic accidents. Research can provide improved methods for detecting and removing contaminants from airport surfaces. Rubber deposit removal, grooving, surface texturing, and innovative chemicals to mitigate the effects of ice and snow are immediate targets. And, the development of aircraft arrestor beds will enhance the level of safety at airports with inadequate overrun areas.

Research continues on strategies for attacking post–crash fires on new multi–level, high density seating, passenger aircraft. Elevated waterways and boom penetration devices are examples of ways to provide increased passenger evacuation protection. Training requirements and firefighting simulators are equally necessary.

The landside portion of airport design and operation is also addressed in this research area. Projects in this area will help ensure that the systems that bring passengers to the aircraft are also able to handle projected traffic levels.

Table 5–1, Major Airport Technology Products, provides a quick overview of major airport technology–enhancing products from R,E&D research efforts.

Table 5–1. Major Airport Technology Products

Program Number	Program Name	Major Products
051–110	Airport Planning and Design Technology	• Aircraft/terminal compatibility analyses • Design standards for terminals and multiple/parallel runway configurations • User guides for use by the FAA airport community and industry
051–120	Airport Pavement Technology	• Three–dimensional finite element models for design of airport pavements • National pavement test machine • Data base for in situ performance information of airport pavements
051–130	Airport Safety Technology	• Technical data supporting rules, regulations, and advisory circulars on runway surface maintenance • Design specification for low–cost mobile firefighting live–fire training facilities • Technical data and design criteria for lighting and marking systems for airports, heliports, and vertiports • Technical data on tests and evaluation of firefighting agents, full-scale systems, and rapid response, all-terrain firefighting vehicle • Technical publications, data, and advisory circulars on wildlife habitat management, bird harassment techniques, landfill studies, and annual U.S. bird strike reports

5.1 Airport Technology Descriptions

* 051–110 Airport Planning and Design Technology

Purpose: Advances in technology have supported major refinements in the air transportation system and made it possible to transport a large number of people, one-half billion passenger enplanements, each year. But ever–increasing travel demand and projected growth in the next 15 years will influence airport design, layout, and configuration, and require improved landside facilities. A major concern facing the U.S. air transportation industry is how to manage increases in air traffic with improved safety, reduced delays, and minimal operational constraints.

As advances in air traffic control and other airport improvements increase airside efficiency and capacity, passenger facility capacity and access to the airport will become a limiting factor. As passenger facility capacity and airport access become the new limiting factors, these choke points will generate greater community interest and involvement. Optimum airport use will require a smooth and uninterrupted flow of passengers, cargo, and airplanes among the various elements of the airport system.

This project will help improve existing, or develop new, design standards pertaining to runways, taxiways, aprons, and gates. It will also develop standards and advisory information to be used in planning and designing airports, terminals, and ground access systems.

Approach: A major goal of this program is to reduce runway occupancy time as much as practical. It will require optimizing the geometry of runway and taxiway exits to allow aircraft to negotiate turns safely at higher speed. Research will also be needed to support changes in airport ground access to respond to concerns about congestion and air quality. In addition, it is necessary to identify the clearance and design requirements of future aircraft and review current airport designs relative to those requirements. Also, simplified methods must be developed for determining terminal, curbside, and airside capacities.

Related Projects: 021–220 Multiple Runway Procedures Development, 024–110 Aviation System Capacity Planning, 051–120 Airport Pavement Technology, 051–130 Airport Safety Technology, and 073–110 Airport Security Technology Integration. Capital Investment Plan projects: F–16 FAA William J. Hughes Technical Center Building and Plant Support and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Galaxy Scientific Corporation
  Pleasantville, New Jersey

Products:

- Technical data to support advisory material, regulations, and guidance used by the FAA and industry
- Computer programs and user guides for use by the FAA airport community and industry
- Design standards for terminals and multiple/parallel runway configurations
- Aircraft/terminal compatibility analyses

1996 Accomplishments:

- Published report on the effect of proposed very large civil transports on airports.

* *Will be combined with program 051–120 Airport Pavement Technology in 1998.*

1997 Projected Accomplishments:

- Issue ground access planning guidance.
- Publish report on the critical research requirements in airport planning and design technology.

Planned Activities:

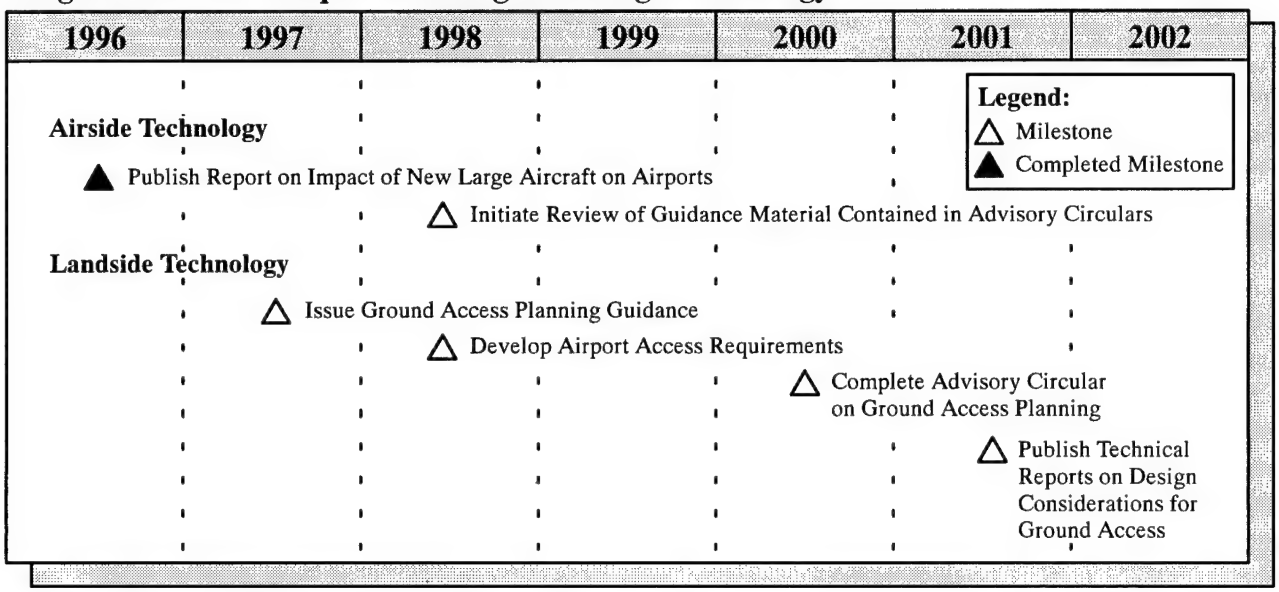
Airside Technology

In 1998, a review of all guidance material contained in advisory circulars will be initiated to identify material that must be revised to adequately inform airport planners and engineers of the potential requirements of larger aircraft.

Landside Technology

In 1998, guidance on cost/benefit analysis will be prepared to help ensure that Airport Improvement Program funds are efficiently used. Also in 1998, airport access requirements will be developed, followed by publication of an advisory circular on ground access planning in 2000. Technical reports on design considerations for ground access will be published in 2001.

Program 051–110: Airport Planning and Design Technology



* 051–120 Airport Pavement Technology

Purpose: The approximately 650 million square yards of pavement at U.S. airports represent a precious national resource. Replacement value exceeds $100 billion, and there are only limited practical possibilities for adding to or replacing major pavement systems. Consequently, maximum benefits must be obtained from the existing facilities.

* *In 1998, this program will incorporate research from program 051–110 Airport Planning and Design Technology.*

The federal government and the aviation community are spending approximately $2 billion annually on pavements. There are additional costs resulting from delays due to construction and maintenance. A significant portion of the $2 billion is spent replacing, repaving, rehabilitating, repairing, and maintaining pavement surfaces. During the next five years, an estimated $30 billion in federal and local funds will be required to provide a more efficient and integrated public–use airport system under the FAA's National Plan of Integrated Airport Systems. Of this total, about half will be required for constructing, maintaining, and rehabilitating airport pavements. The majority of this money will be spent at the most heavily used airports carrying the largest aircraft.

The goal of this program area is to reduce the large pavement costs by at least 10 percent by 2010. These savings will be achieved through a systematic research program addressing three areas: pavement design and evaluation, pavement materials and construction methods, and pavement maintenance and repairs.

Specific projects will be carried out to develop an integrated method for pavement design that will reduce pavement design and construction costs, minimize pavement failures, lower the costs of maintenance, and reduce pavement downtime and aircraft delay costs. A new pavement design procedure based on layered-elastic theory has been introduced to support U.S. aircraft manufacturers' efforts to introduce new aircraft. Development of advanced design procedures is currently underway to assure that airport pavement designs will be able to serve new large aircraft. The new methodology supports U.S. efforts in working with the International Civil Aviation Organization towards adopting a revised, internationally accepted basis for determining if airport pavements are compatible with new aircraft designs.

Approach:

Pavement Design and Evaluation

Airport pavement design techniques have evolved from the highway design theory developed in the 1920's and extrapolated in the 1940's and 1950's for aviation applications. While this has worked reasonably well in the past, it will not accommodate the dramatic changes associated with new generation aircraft now on the drawing boards. Research in the technical area of pavement design and evaluation will focus on the development of an advanced design procedure for airport pavements that can be used for both flexible and rigid pavements. As a first step, the FAA has issued a new pavement design standard based on the layered–elastic method to support the introduction of new aircraft. Models to better describe pavement materials and material properties will be developed and incorporated into the advanced pavement design procedure. As part of the development of advanced design procedures, full–scale testing will be performed using the national airport pavement test machine.

To study in situ behavior and long–term performance of airport pavements, field data of pavement response to aircraft loads and environmental conditions will be collected at major airports by monitoring instrumented runways and taxiways. Research will be conducted to develop criteria and methods for design, evaluation, performance, and serviceability of pavements at airports in cold regions.

Pavement Materials and Construction Methods

Research efforts in this area will include: developing methods to specify and use new or improved materials as substitutes for conventional pavement construction materials; identifying factors affecting airport pavement durability; and developing criteria for efficient use of devices, construction materials, and construction techniques.

Studies will be conducted to investigate in–service performance of stabilized–base materials, develop corresponding failure criteria for these materials, and formulate material models that will be implemented in design procedures.

Pavement Maintenance and Repairs

Research will be conducted to determine probable causes of significant pavement distress and life–cycle costs.

A new program, the National Registry of New Airport Pavements, will be initiated for organizing long–term data collection on pavement performance. This program will identify new airport construction projects, determine life cycle costs, and quantify other performance factors for all airports included in the data base.

Related Projects: 051–110 Airport Planning and Design Technology and 051–130 Airport Safety Technology. Capital Investment Plan projects: F–13 NAS Facilities Occupational Safety and Health (OSH) and Environmental Compliance, F–16 FAA William J. Hughes Technical Center Building and Plant Support, F–18 Aeronautical Center NAS Support Facilities, and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Galaxy Scientific Corporation
  Pleasantville, New Jersey
- University of Nevada
  Reno, Nevada
- University of Illinois
  Urbana–Champagne, Illinois
- Northwestern University
  Evanston, Illinois

Products:

- Technical data for pavement design and design life, evaluation, materials, construction, maintenance, and repair
- Three–dimensional finite element models for design of airport pavements
- National pavement test machine
- Pavement design tools and guidelines
- National Registry of New Airport Pavements data base
- Data base for in situ performance information of airport pavements

1996 Accomplishments:

- Awarded contract for design and build of research pavement test machine.
- Completed the first pavement response study at Denver International Airport.

1997 Projected Accomplishments:

- Complete national airport pavement test machine design.
- Complete national study of airport pavement performance.
- Complete the first pavement performance study at Denver International Airport.
- Complete development of the National Registry of New Airport Pavements data base.

Planned Activities: Extensive research will continue on design and evaluation standards,

materials application, construction technology, and pavement maintenance and repair requirements. Major task components include developing: pavement design and analysis methodology based on advanced computational techniques; pavement testing and quality control acceptance criteria; specifications for materials; joint sealant criteria; pavement performance data base; and state-of-the-art pavement evaluation techniques.

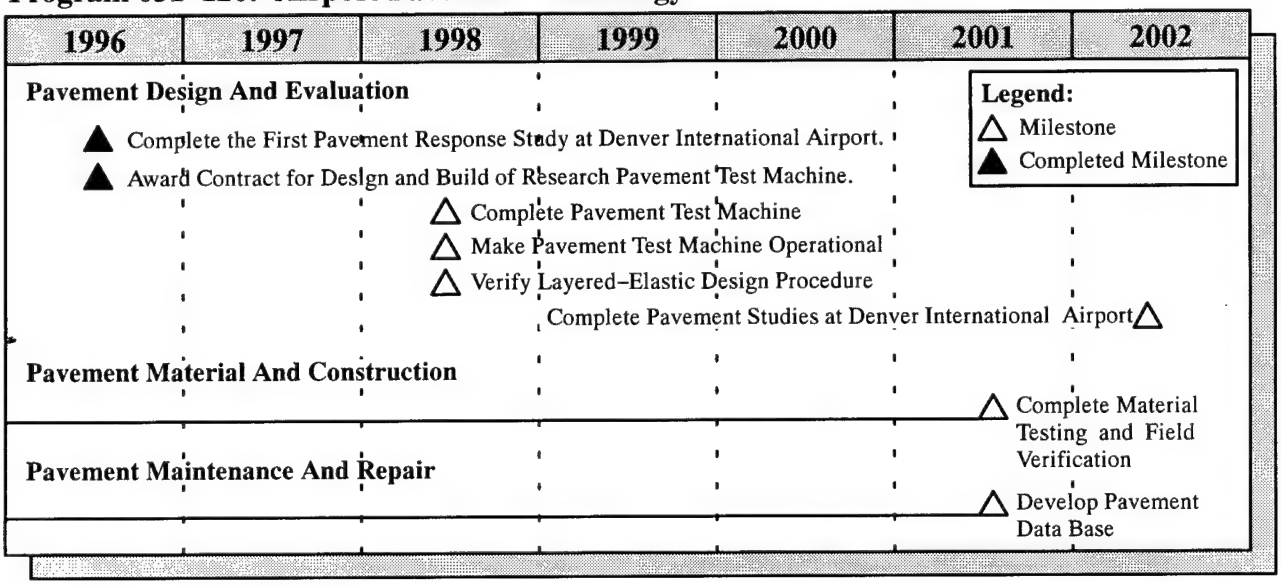
From 1998-2002, a multi–year runway data collection effort will continue at Denver International Airport using sensors embedded in the pavement. These sensors will measure the pavement response and performance to repeated heavy aircraft loading. Field–measured data at Denver International Airport will be stored in the data base accessible on the Internet. This data will be used to validate pavement design theories. Development of advanced design procedures, field investigation, laboratory testing, and material modeling will be completed in 2001. Full–scale testing will begin in 1998.

Computer software development using the predictive design and analysis methodology will continue in 1998, resulting in a stress/strain graphic display in 2000.

In 1998, work will continue on collecting and analyzing data that relate pavement performance to FAA design and construction standards. This effort will result in a comprehensive airport pavement data base in 2001. Criteria and methods for design, evaluation, performance, and serviceability of pavements at airports in cold regions will be developed.

In 1998, national pavement test machine construction will be completed, and the machine will become operational. Experiments will be continually run on new materials as they are developed, on new construction techniques, and on pavement lifecycle determination methods. Pavement design tools based on finite element analysis will be completed in 2000. The pavement test machine will be used to conduct various experiments such as verifying the layered-elastic design procedure in 1999.

Program 051–120: Airport Pavement Technology



051–130 Airport Safety Technology

Purpose: This program will develop new technologies in four research areas: (1) safe and efficient aircraft operations on runway surfaces; (2) new, emerging technologies in lighting, signing, and marking materials for improved visual control systems; (3) new materials, methods, and equipment to improve the capability and cost–effectiveness of airport rescue and firefighting services; and (4) materials, methods, and devices to control birds and wildlife in the airport environment.

Approach:

Runway Surface Technology

A critical safety concern at airports is the runway surface condition. Snow, ice, water, and rubber deposits can result in slipperiness, causing aircraft loss of control during braking as well as making surface movements hazardous. In recent years, grooved runways to control surface water have greatly reduced hydroplaning. However, aircraft accidents from overshooting or veering off contaminated runways remain a problem.

From 1980 to 1991, there were 130 accidents involving aircraft overruns and veeroffs. The accidents involved runway surfaces that were either dry or covered with water, ice, snow, or slush. Major aircraft accidents have focused national attention on the question of runway slipperiness and loss of control during landings and takeoffs. Two recent accidents at La Guardia Airport in 1992 and 1994 identified runway slipperiness and an inadequate safety area beyond the end of the runway as contributing factors.

The goals of this project are to eliminate by 2000 runway slipperiness as a cause of accidents and develop technologies to safely stop all aircraft within the extent of the runway. To achieve these goals, extensive research, testing, and evaluation will be conducted to develop new techniques, materials, procedures, and equipment to remove ice, snow, and rubber deposits efficiently with minimal adverse environmental impact. Also, research will continue on developing methods to prevent ice and snow accumulation on airport surfaces. In addition, new materials and methods will be investigated to decelerate aircraft safely should there be an overrun.

Visual Guidance

Safe and efficient airport ground operations, especially at night and under low visibility conditions, require that pilots and vehicle operators receive conspicuous and unambiguous information from lights, signs, and markings. Improvements in these visual aids will help to eliminate runway incursions.

During the past 15 years, seven air transport surface collisions in the United States have resulted in 17 fatalities and substantial property damage. In 1990, a collision at Detroit International Airport between two aircraft killed eight people. These accidents have brought into focus the need for providing improved visual guidance to aircraft in low visibility conditions.

The goal of this program area is to eliminate by 2000 deficiencies in visual guidance systems and procedures that may contribute to surface collision accidents. This goal will require research efforts in two general areas: visual guidance "control" technology to develop an advanced system for aircraft movement on airport surfaces and developing state–of–the–art light sources and applications. These will include fiber optics, laser sources, and holographic techniques. In conjunction with this effort, technology will be developed to evaluate new visual guidance systems and procedures, particularly during low visibility conditions, on a computer–based simulation system.

Rescue and Firefighting

An analysis of aircraft accidents involving external fuel fires has shown that, although external fires can be effectively extinguished, secondary fires within the fuselage are difficult to control with existing equipment and procedures. Large amounts of smoke, toxic gases, and high temperature levels in the passenger cabin can cause delay in evacuation and pose severe safety hazards. The 1991 accident at Los Angeles International Airport involving two aircraft clearly demonstrated this concern. The rescue and firefighting personnel were faced with a post–crash fuel spill fire, a rapidly growing interior fire, and a structural fire. A rapid response to the accident site was accomplished, but evacuation was hampered by the thick black smoke that filled the cabin following the accident.

The goal of this program area is to increase passenger survival rates in post–crash fires by providing a safe evacuation route from the aircraft cabin in a timely manner. This goal will require research and testing to develop firefighting systems that can effectively be used to control both external and internal cabin fires. New methods, procedures, and firefighting chemicals will be developed for large-capacity aircraft, double–decked aircraft, and/or aircraft made from advanced materials. Research will be carried out to reduce vehicle response during nighttime and low visibility conditions, and to develop new training techniques for rescue and firefighting personnel. Improvements in response times and proper equipment development are needed for operations in poor visibility conditions.

Increased high–speed stability and vehicle dynamic rollover requirements necessary for making rapid emergency responses will require development of new rescue vehicle designs with reduced rollover tendencies. Improvements in soft terrain and off–road firefighting vehicle capabilities will be needed to cope with expanded airport runway configurations into 2000 and beyond. Reductions in off–runway response times will be achieved by developing a new truck suspension system that improves traction in soft sand and wet/uneven ground conditions.

In addition, advanced educational programs using interactive computer–generated simulator equipment will be developed to provide rescue drivers the opportunity to practice high–speed response requirements without putting drivers and needed equipment at risk at training schools.

Chemicals used in airport firefighting are raising concerns about environmental damage. Research will investigate methods to maintain a high level of performance for firefighting services while minimizing air pollution and ground water contamination.

Wildlife

Wildlife presence at or near airports poses a potential threat to movement of aircraft and other ground vehicles. In spite of various control devices in use to keep birds away, over a thousand bird strike incidents are reported every year. Many more incidents are known to occur, but are not reported.

Since 1912, when the first fatal accident of a Wright Flyer was recorded, 104 civil aviation fatalities from bird strikes have been reported in the United States. Worldwide civil aircraft fatalities total approximately 126, and the potential for a serious accident continues. Bird strike damage cost has been estimated at $1 billion annually by the Europe Bird Strike Committee.

The goals of this program are to increase airport safety and decrease damage to aircraft by reducing bird strikes. These goals require research efforts in developing effective regional wildlife habitat management to minimize or eliminate sources of bird attraction at airports. A computer data base compiling annual U.S. bird strike reports was added as a component of this research project in 1995 to provide data on this significant

aviation statistic. Research will also be conducted to identify active and passive harassment techniques that can effectively control the presence of birds and other wildlife at airports. These techniques and methods will assist airport owners and operators in complying with FAA airport certification regulations. Land use siting compatibility guidance will be provided by researching relationships among birds, airports, and landfills.

Related Projects: 022–140 General Aviation and Vertical Flight Program, 051–110 Airport Planning and Design Technology, 051–120 Airport Pavement Technology, and 061–110 Fire Research and Safety. Capital Investment Plan projects: F–13 NAS Facilities Occupational Safety and Health (OSH) and Environmental Compliance, F–16 FAA Technical Center Building and Plant Support, F–18 Aeronautical Center NAS Support Facilities, M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance, and N–04 Visual Navaids.

University/Contractor Support:

- Galaxy Scientific Corporation
  Pleasantville, New Jersey
- Engineered Systems Company
  Aston, Pennsylvania
- Port Authority of New York and New Jersey
  New York, New York
- Superior Graphite, Inc.
  Chicago, Illinois
- Process Technologies, Inc.
  Buffalo, New York

Products:

- Technical data supporting rules, regulations, and advisory circulars on runway surface maintenance
- Design specification for low–cost mobile firefighting live–fire training facilities
- Technical data and design criteria for lighting and marking systems for airports, heliports, and vertiports
- Technical data on tests and evaluation of firefighting agents, full-scale systems, and rapid response, all-terrain firefighting vehicle
- Technical publications, data, and advisory circulars on wildlife habitat management, bird harassment techniques, landfill studies, and annual U.S. bird strike reports

1996 Accomplishments:

Runway Surface Technology

- Published technical report on design and installation of the prototype aircraft arrestor bed at JFK International Airport.
- Published technical report on electrically conductive asphalt pavements.
- Published technical report on experimental system to ground de–ice aircraft with infrared energy.

Visual Guidance

- Published recommended specifications for improved elevated runway guard light fixtures.
- Completed study for identification of key components for an advanced visual guidance system.
- Designed prototype advanced visual guidance system.

- Issued report on simulation study for the potential redesign of approach lighting systems.

- Conducted initial evaluations of new technology as applied to visual guidance.

- Completed testing of jet blast/wake turbulence forces on airport signs.

- Completed testing on incompatibility of constant intensity signs and flashing light devices with constant current regulators.

- Completed testing and issued report on prototype light fixtures for declared distance runway lighting configurations.

- Issued report on approach path indicators for heliports.

- Completed phase II of approach lighting systems simulator evaluation and issued report.

Rescue and Firefighting

- Completed mission response study of airport fire protection requirements for Congress.

- Performed full–scale interior fire suppression demonstration using an FAA–developed boom–mounted aircraft cabin skin penetration system.

- Developed airport firefighting attack strategies using an elevated waterway device and a boom–mounted interior firefighting penetration appliance.

- Developed and validated a full–scale fire testing program, minimum fire protection requirements for all FAA–certified airports.

Wildlife

- Published first U.S. bird strike report, fifth report on wildlife harassment/deterrent techniques for airports, and third report on landfill studies.

- Published first regional wildlife habitat management study at Atlantic City International Airport.

1997 Projected Accomplishments:

Runway Surface Technology

- Publish interim report on the durability of aircraft arrestor beds in an operational environment.

- Publish technical report on innovative ways to prevent, weaken, or eliminate the ice/pavement bond during winter operations.

- Publish technical report on techniques for assessing runway friction restoration/pavement damage as a result of rubber deposit removal.

- Complete design and begin installation of a second arrestor bed at a major U.S. airport.

- Evaluate aircraft ground de–icing facilities using infrared energy.

- Develop means to acquire and report runway surface friction values for pilot use.

Visual Guidance

- Complete installation/evaluation of prototype advanced visual guidance system.

- Recommend standards for a new mode of airport signs designed to be installed at critical jet blast/wake turbulence locations.

- Complete evaluation of enhanced taxiway exit identification system.

- Complete evaluation of light emitting diode programmable variable message airport signs.

- Complete new technology approach lighting demonstration tests and evaluation and issue report.

Rescue and Firefighting

- Publish final report highlighting gains in firefighting effectiveness through adopting new technologies such as FAA–developed elevated boom, cabin skin penetration systems, driver enhanced vision, and poor visibility technology.

- Complete final report on the results of the full–scale fire test validation program.

- Develop advisory circular (AC) detailing fire protection requirements for fires on composite constructed aircraft.

- Develop specification for an interactive, computer–generated simulator to provide rescue drivers the opportunity to practice high–speed rescue response.

- Update current fire protection advisory circular to include new–generation transport aircraft, such as the Boeing 777.

Wildlife

- Publish the second U.S. bird strike report.

- Publish first Mid–Atlantic U.S. advisory circular on Atlantic City wildlife habitat management study.

Planned Activities:

Runway Surface Technology

Observation and assessment of aircraft arrestor bed technologies will lead to an advisory circular in 1998. Updating of the mathematical model will continue with addition of new transport aircraft and arrestor materials through 2002.

In 1998, research will continue on innovative ways to prevent, weaken, or remove the ice/pavement bond during winter operations, leading to an advisory circular in 2001.

In 1998, research will continue on pavement damage due to repeated rubber deposit removal operations. In 1999, a user guide will be developed to optimize rubber deposit removals without reducing pavement life.

Observation and evaluation of operational infrared aircraft de–icing facilities will continue through 1998, leading to a report in 1999.

In 1998, research methods to acquire and report runway friction values for pilot use will be developed, leading to an advisory circular in 2002.

In 1998, an advisory circular will be published on optimal types and rates of abrasives to restore pavement friction.

Visual Guidance

In 1998, an evaluation will continue on a prototype advanced visual guidance system that controls and guides aircraft taxiing to and from the runway in all weather conditions. In 1999, the evaluation will be completed, leading to standards in 2000.

In 1998 through 2002, advanced technology lighting sources will be evaluated for potential inclusion in more efficient airport and approach visual guidance systems. Fiber optic and more efficient light sources for approach and airport lighting use will be evaluated at the FAA William J. Hughes Technical Center in 1998, followed by field prototype and evaluation. Performance specifications for approach lighting systems will be recommended in 1999.

Rescue and Firefighting

In 1998, work will continue on evaluating strategies for attacking post-crash fuel fires on new, multi-level, high density seating passenger aircraft. Elevated waterways and boom penetration devices will be used to provide increased passenger evacuation protection for aircraft having five hundred or more passengers. Also in 1998, work will continue on developing training requirements as well as operational strategies for firefighting response at airports conducting operations to zero visibility, zero ceiling weather conditions. Also in 1998, work will continue on providing fire truck crews with information for efficient movement on the airport during rescue operations following a crash. Efforts will continue on evaluating the rescue firefighting standards against requirements to control and extinguish fires in aircraft containing composite material.

In 1998, an evaluation will be continued for aircraft rescue and firefighting training simulators. A study will begin on a model, full–scale firefighting training facility that meets both environmental concerns and operational requirements. Based on this research, the current training advisory circular will be updated in 1999 for a standardized, model firefighting training simulator. In addition, a performance standard will be established that measures firefighter training efficiency using propane simulators versus real hydrocarbon fuel training.

It is expected that the current fire protection advisory circular will be updated again in 2000 to include fire protection for aircraft in the 600–800 passenger capacity.

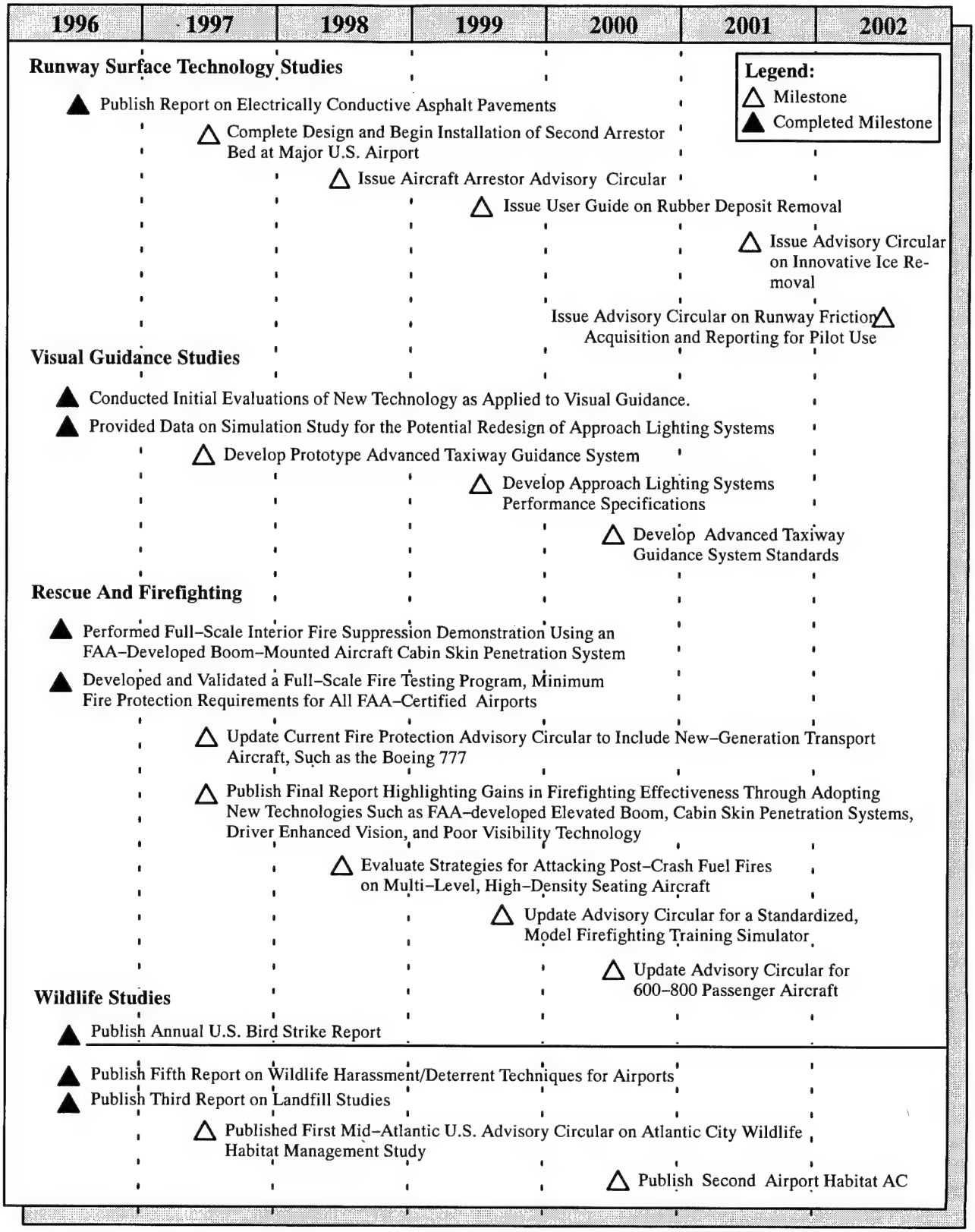
Wildlife

In 1998, the second regional airport habitat management study at O'Hare International Airport will be completed, with publication expected in 1999. Also in 1998, research on a sixth wildlife harassment/deterrent technique will be completed, and landfill studies will continue.

The North Central U.S. advisory circular will be published in 2000, based on the 1999 O'Hare report. The third regional habitat study will begin in 1999 and conclude in after 2002. A final report on the seventh wildlife harassment/deterrent technique will be finished in 1999. Regional habitat management studies will be initiated and completed every 2 years until the 10 regional studies are finished. These regional airport studies will continue through 2002, with advisory circulars published 1 year after final reports. In 1998, the third annual U.S. bird strike report will be published. Also in 1998, landfill studies will continue as scientific evidence describes the link between gull populations and solid waste facilities as well as their effects on airports and aircraft traffic.

The primary thrust of the wildlife research efforts is to identify and document the effectiveness and applicability of new wildlife habitat management and harassment/deterrent techniques for use on or near airports to mitigate bird and wildlife hazards. Increased knowledge of bird relationships to existing and new solid waste facilities will establish an enhanced scientific basis to evaluate potential bird attraction effects on or near airports.

Program 051–130: Airport Safety Technology



6.0 AIRCRAFT SAFETY TECHNOLOGY

Today's passenger safety depends on fault–free maintenance and operation of the nation's civil aircraft. Tomorrow's passenger safety depends on steps taken now to ensure future aircraft reliability and their operator's competency. The steps taken today by the FAA for future safety are embodied in aircraft safety technology research. This research addresses the many hazards that face all aircraft in flight, as well as special hazards endemic to select portions of the civil aircraft fleet. Older aircraft are more susceptible to structural problems associated with fatigue and corrosion. New aircraft, with their digital flight control and avionics systems and associated imbedded software, are more susceptible to upset from external electromagnetic interference. The main hazards addressed are represented in Figure 6–1.

Aircraft safety improvements will reduce fatalities and injuries, reduce hull losses, improve aircraft designs, and impact maintenance and inspection procedures. Each aircraft safety program has the potential to provide significant benefits. For example, more efficient nondestructive airframe testing could produce $40 million per year in benefits. A similar improvement in engine maintenance efficiency could achieve $20 million per year in benefits. An additional $30 million per year could accrue from these two programs due to using more effective inspection techniques and avoiding major engine failure incidences.

Research in aircraft fire safety has the potential for accruing large benefits. Statistics show the United States has about 30 to 35 fire fatalities per year in otherwise survivable accidents, and about 135 fatalities worldwide. At an estimated cost of $1.5 million per life, saving 3 people per year would pay for the entire fire safety research, engineering, and development effort. Over the past 20 years, the aircraft accident fatality rate has been nearly level at just under two deaths per 10 million passengers carried. This statistic is a tribute to aircraft safety provided by the designers, operators, and regulators. Because the civil fleet's size increased over this period, the leveling fatality rate translates into an increase in total fatalities. These statistics indicate that new safety problems have been arising as old ones have been eliminated. Further, some safety problems such as fire and crashworthiness have continued to persist. Other potential problems, such as flight critical software–based digital fly–by–wire flight control systems, have not had sufficient operational exposure.

Maintaining the good safety record over the past two decades has required introducing new safety technologies, such as cabin floor emergency escape lighting and seat fire blocking layers. Such enhancements are in addition to scores of pre–existing safety requirements for aircraft. Examples include design requirements for the aircraft structure so occupants can survive rapid decompression at cruise altitudes and demonstrations proving that all cabin passengers can evacuate within 90 seconds for each newly certificated transport category model. The most important purpose of FAA aircraft safety research is to develop technical requirements for safety improvements needed to maintain or improve the safety level in an evolving aviation environment and to improve the dissemination of safety data and analysis to the aviation industry and the general aviation public.

Table 6–1, Major Aircraft Safety Technology Products, provides a quick overview of major safety–enhancing products from R,E&D research efforts.

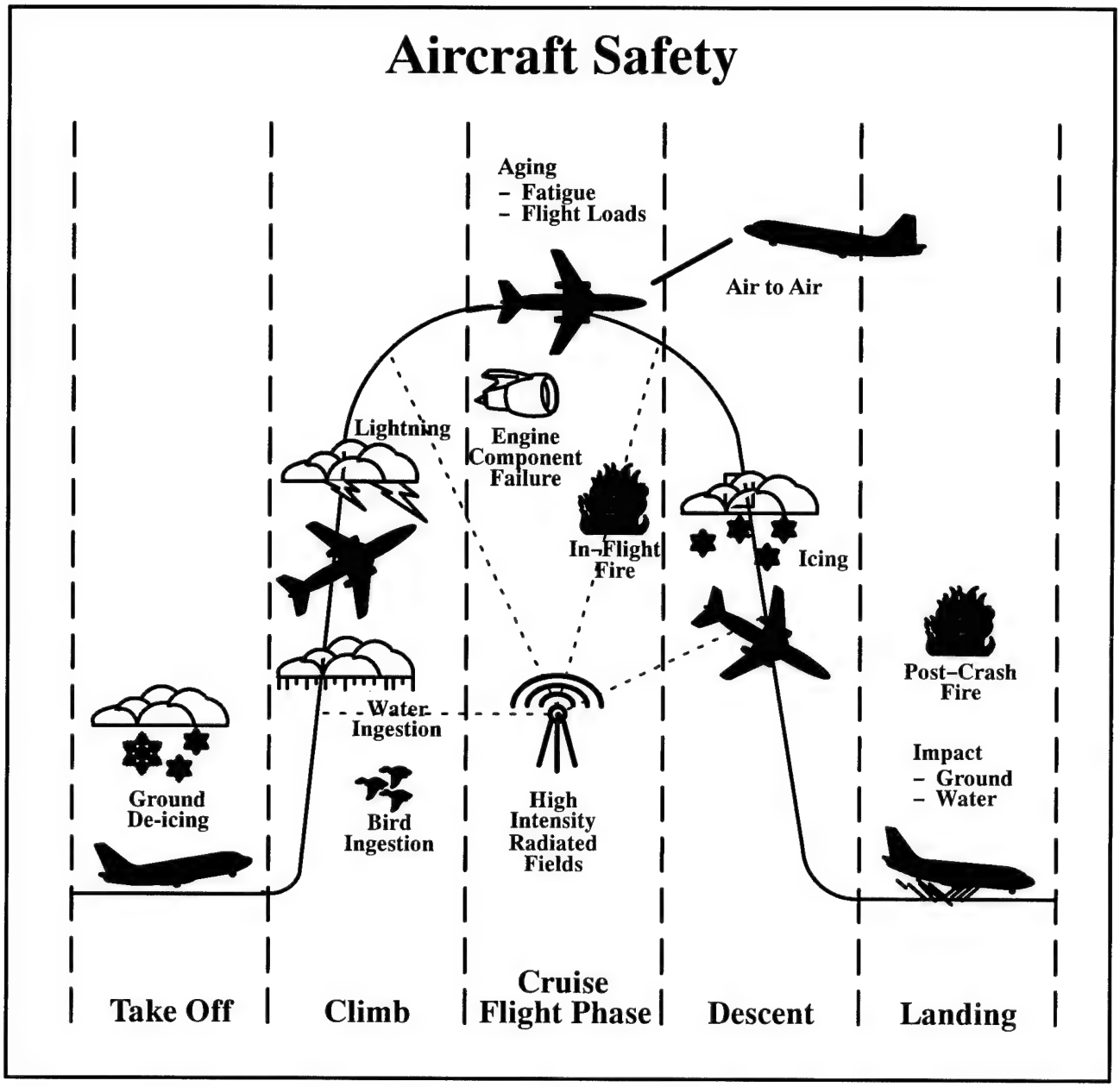


Figure 6–1. Aircraft Safety

Table 6–1. Major Aircraft Safety Products

Program Number	Program Name	Major Products
060–110	Aviation Safety Risk Analysis	• Safety performance analysis systems that provide safety–critical performance indicators on aircraft, air operators, air agencies, and air personnel • Aviation safety management system for identifying and managing risks that relate to aircraft certification for each category of aircraft and its usage
061–110	Fire Research and Safety	• Requirements for approving Halon–alternate extinguishing agents • Data for improved fire hardening of fuselage structures • Fire–safe emergency oxygen system improvements • Totally fire-resistant materials for fabricating aircraft cabin interiors • Microscale heat release rate device for testing flammability of milligram sample quantities to upgrade performance criteria for molded cabin parts and electrical wiring • Cooperative joint cabin safety research agreement among FAA, Joint Airworthiness Authority (JAA), and Transport Canada (TCA) • Cabin safety risk/benefit analysis models
062–110	Advanced Materials/Structural Safety	• Handbooks for FAA personnel and industry on new composite technologies and manufacturing/inspection analysis techniques • Data package for certification of structures constructed using advanced materials • Data package addressing certification criteria for seat/restraint systems • Technical data packages on crash–resistant auxiliary fuel system designs
063–110	Propulsion and Fuel Systems	• Probabilistic engine rotor design code • Manufacturing specification for advanced titanium alloy production • Recommendations for certification standards on general aviation unleaded fuels
064–110	Flight Safety/Atmospheric Hazards	• Aircraft surface ice detection technologies and systems • Characterization of the large, super–cooled droplets icing atmospheric environment • Electromagnetic threat definition, development, and validation • Technical report on flight critical digital systems technology studies for assessment and development of airworthiness and certification methods
065–110	Aging Aircraft	• A maintenance and inspection management program that will be used to derive regulatory documents for commercial pressurized engine cases • Analytical tools and models to assess commuter and transport aircraft structural integrity and repairs • Technical data used to formulate the Special Federal Airworthiness Regulation and advisory circulars on widespread fatigue damage and the corrosion fatigue interaction • Technical data that can be used for design, certification, and airframe life assessment for flight and ground loads encountered by transport and commuter airplanes • Training tools, aids, and material for repair, maintenance, and inspection personnel • Inspection systems for flaw detection in airframe structures and engines for compliance certification • Supplemental inspection documents for commuter category airplanes to provide for the continuing airworthiness of the commuter fleet

Table 6–1. Major Aircraft Safety Products

Program Number	Program Name	Major Products
066–110	Aircraft Catastrophic Failure Prevention Research	• Model of uncontained debris from turbine engine rotating component failures • Risk assessment analysis methodology tools • Failed–mode flying qualities assessment system and situational awareness/cockpit resource management procedures

6.1 Aircraft Safety Technology Program Descriptions

060–110 Aviation Safety Risk Analysis

Purpose: The FAA's workload for ensuring aviation safety is increasing due to multiple factors such as air traffic growth, aging aircraft, and the introduction of new technologies. This program will provide automation and decision support systems such as the safety performance analysis system (SPAS) and the aviation safety management program to aviation safety inspectors and certification engineers to allow them to systematically assess potential risks and take proactive steps to reduce the rate of aviation–related accidents or incidents. Cost and safety benefits derived from this program will also extend to aviation–related industries and society as a whole.

Approach: This program will provide FAA field inspectors, certification engineers, and industry specialists safety management automation tools applicable to aircraft type certification, flight operations, and continued airworthiness. These tools will require the development of performance measures; analytical engines; improved data collection protocols; data standardization; data storage, archival, and retrieval mechanisms; data bases; and wide area telecommunication improvements.

Development of performance measures involves the following steps: defining the metric(s); identifying the data elements and data sources; determining the appropriate analytical methodology; quantifying the metric(s) and their acceptable limits; validating the methodology; prioritizing the risk factors; and implementing the measures into a software tool.

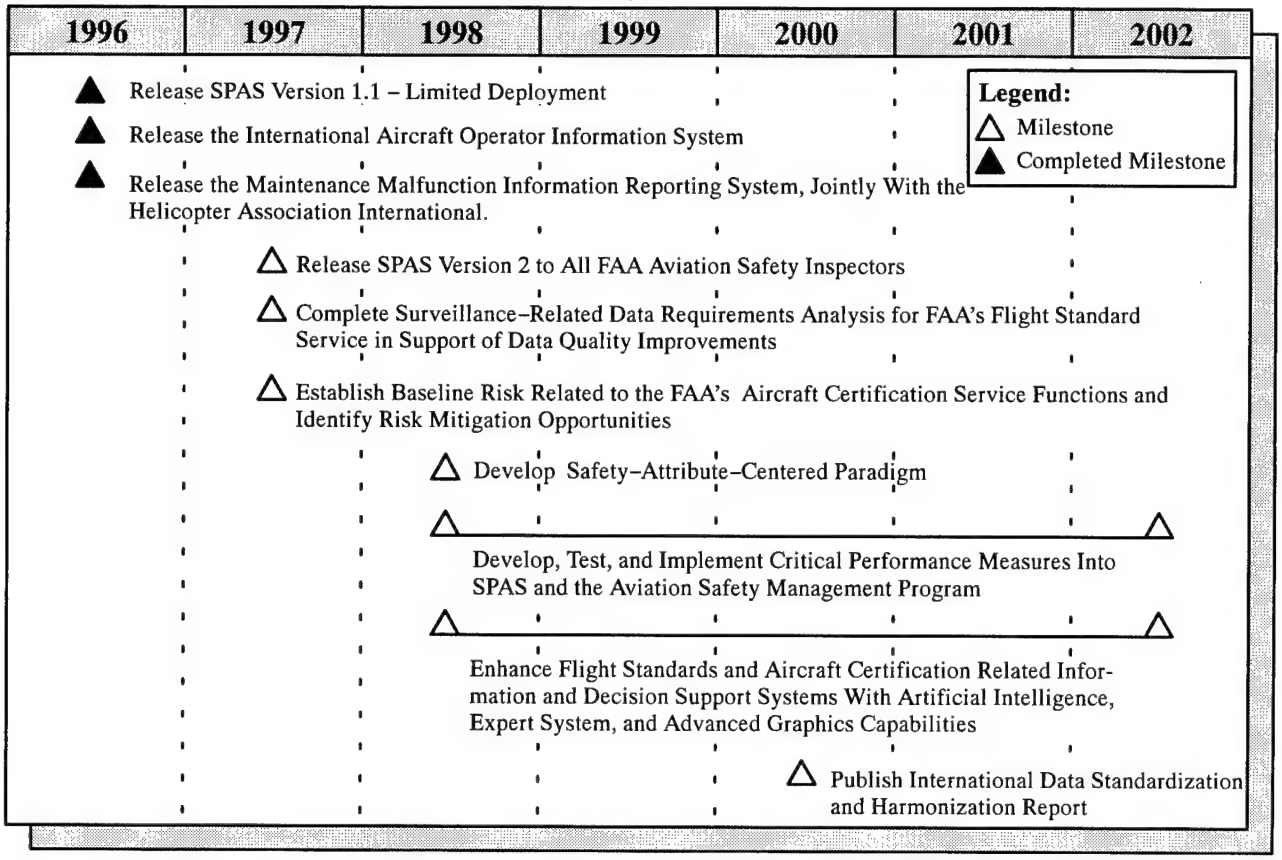
Related Projects: 061–110 Fire Research and Safety, 062–110 Advanced Materials/Structural Safety, 063–110 Propulsion and Fuel Systems, 064–110 Flight Safety/Atmospheric Hazards, 065–110 Aging Aircraft, and 066–110 Aircraft Catastrophic Failure Prevention Research. Capital Investment Plan programs: A–15 Civil Aviation Registry Modernization, A–17 Aviation Safety Analysis System (ASAS), A–18 Safety Performance Analysis System (SPAS), F–16 FAA William J. Hughes Technical Center Building and Plant Support, M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance, M–18 Computer Resources Nucleus (CORN), and M–24 National Aviation Safety Data Analysis Center (NASDAC)

1997 Projected Accomplishments:

- Released the maintenance malfunction information reporting system, jointly with the Helicopter Association International.
- Release SPAS Version 2 to all FAA aviation safety inspectors.
- Complete surveillance–related data requirements analysis for FAA's Flight Standard Service in support of data quality improvements.
- Establish baseline risk related to the FAA's Aircraft Certification Service functions and identify risk mitigation opportunities.

Planned Activities: In 1998, development efforts on risk assessment and information display capabilities will continue. Critical performance measures to support both flight standards and air certification personnel will be developed, tested, and implemented into existing analytical systems such as SPAS and the aviation safety management program. In addition, flight standards and aircraft certification related information and decision support systems will be continually enhanced with artificial intelligence, expert system, and advanced graphics capabilities. These enhanced capabilities, when validated and approved, will be implemented beginning in 1998.

Program 060–110: Aviation Safety Risk Analysis



061–110 Fire Research and Safety

Purpose: Developing near term fire safety improvements to prevent uncontrollable in–flight fires and increase postcrash fire survival rates, and conducting long–range fire research to develop ultra–fire resistant cabin materials is the goal of this program. Improvements in materials, aircraft fire safety design, fuselage burnthrough resistance, fire management systems as well as aircraft certification of Halon replacement extinguishing agents will be developed and validated by full–scale fire tests. This program's objective is to develop a totally fire–proof passenger cabin design in accord with the 1988 Aviation Safety Research Act and consistent with the FAA's world leadership role in research, development, and implementation of aircraft fire safety design improvements. Another objective of this program is coordinating the diverse cabin safety research activities related to evacuation crash dynamics, fire, and in–flight medical emergencies on an international level.

Approach:

Fire Safety

The part of this program dedicated to near–term fire safety improvements is comprised of three general areas: materials fire safety, fire management, and systems. Fire problems in specific aircraft applications will be solved or ameliorated using the best existing fire technology determined by full–scale tests.

Materials Fire Safety. The first task under this activity will provide data which could be used in design guidelines for hardening aircraft fuselages against burnthrough by an external post–crash fuel fire. Analyses of aircraft crash fires indicates that the fuselage is intact in 50% of accidents, yet there are no standards that address fuselage burnthrough resistance. Materials and components which will be tested for improved burnthrough resistance will focus on the thermal–acoustical insulation.

Current Fiberglass Insulation After About 2 Minutes Exposure to Jet Fuel Fire

The second task involves the development of fire test methods for cabin and structural materials in future aircraft designs such as the high–speed civil transport (HSCT) and large capacity, double–decked airplanes, called very large commercial transports (VLCT). With respect to the HSCT the primary focus will be on the composite fuselage skin. Full–scale tests will be conducted on aircraft fuselages employing composite skins to determine the hazards associated with exposure to a post–crash fuel fire and to reduce the impact of these hazards on passenger evacuation. In the VLCT the vulnerability of the upper deck to a post–crash fire, the chimney effect, is a major concern. A double–decked fuselage testbed will be constructed to examine each issue and develop design improvements.

The final task harmonizes and improves the standardization of existing fire test methods required by the FAA and foreign airworthiness authorities. This effort is accomplished by an International Aircraft Material Fire Tests Working Group, chaired and administered by the FAA.

Fire Management. The first task under this activity is to conduct tests which will lead to revised certification criteria to approve new fire extinguishing agents as effective as Halons. Production of Halons ceased on January 1, 1994, by international agreement, because of their contribution to the depletion of the ozone layer. Halons are currently used in aircraft fire extinguishing systems; however, with the diminishing availability and high costs of recycled Halon, new agents are being developed and need to be tested by FAA to determine their effectiveness. Industry participation and harmonization with foreign airworthiness authorities is obtained through the International Halon Replacement Working Group, chaired and administered by the FAA.

The second task involves the development of a cabin water spray fire–suppression system to improve passenger survivability during post–crash fires. The double–decked fuselage testbed will be employed to evaluate the effectiveness of water sprays in very large transports such as the VLCT, carrying 800–1000 passengers, where the potential for fire fatalities is far greater.

The final task will be to develop a standardized test procedure to certify cargo compartment fire/smoke detectors. No standards exist, and it is likely that the level of safety varies for different FAA–approved detectors.

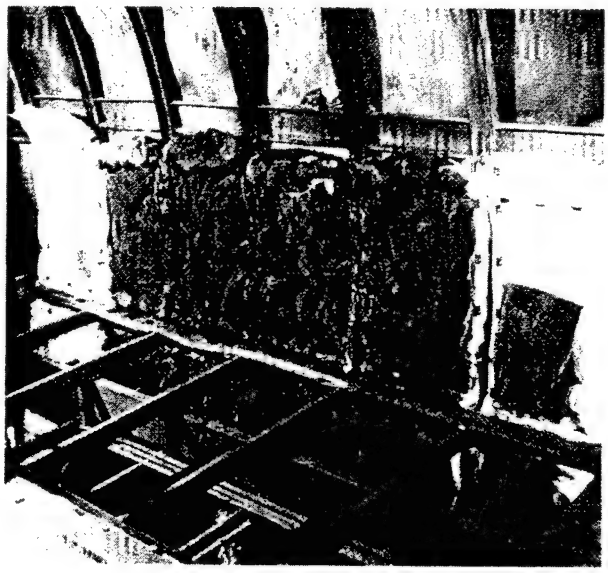
Systems. Malfunction or damage to vital aircraft systems may cause fires or accelerate the spread of fire. Emphasis will be placed on emergency oxygen systems because these systems are the most likely to cause or accelerate aircraft fires. Based on a review of accidents, incidents, and service problems, full–scale tests will be

conducted on aircraft oxygen systems to identify near–term design changes that can eliminate or reduce oxygen–fed fires. Also, the feasibility of new technologies such as gas membranes to provide an onboard inert gas generating system (OBIGGS) as a replacement for bottled oxygen and chemical cannisters will be determined.

Fire Resistant Materials

Fire research will focus on developing fire–resistant materials, in close collaboration with industries and universities. To date, over 20 Fortune 500 companies are contributing directly to the FAA's fire resistant materials research efforts through university consortia.

This project seeks to eliminate cabin fire as a cause of fatalities in aircraft accidents by developing polymer and composite cabin materials with significantly reduced ignitability, smoke, and heat release compared to current FAA requirements. Novel synthetic chemistry, process research, and fundamental studies of materials flammability will lead to non–combustible cabin components which are lightweight, serviceable, and environmentally sound. The goal is a totally fire–resistant cabin for next–generation aircraft.



New Heat Stabilized Polyacrylonitrile Insulation After About 5 Minutes and 30 Seconds Exposure to Jet Fuel Fire

Advanced material research will require determining the fundamental relationships between material composition and behavior in aircraft fires. To determine these fundamental relationships, the program will employ molecular modeling to predict fire test performance of new fire–resistant materials. This modeling will provide the basis for synthesizing new materials and developing new combustion and structural response models that can be used in aircraft materials design.

Novel materials emerging from this long–range program will improve ground transportation fire safety and find application in the fire/thermal protection, electronic, and biomedical industries.

Cabin Safety

The cabin safety portion of this program will assemble an international working group composed of regulatory authorities and research personnel. Comprehensive risk/benefit analysis models and data bases on past accidents and incidents involving cabin safety will be developed. Computer models will also be developed to evaluate passenger evacuation under various scenarios to identify and prioritize problem areas. Risk/benefit analyses, data bases, and evacuation models are the tools the working group will employ to set research priorities by evaluating the total cabin safety picture.

Related Projects: 051–130 Airport Safety Technology, 060–110 Aviation Safety Risk Analysis, 062–110 Advanced Materials/Structural Safety, 063–110 Propulsion and Fuel Systems, 064–110 Flight Safety/Atmospheric Hazards, 066–110 Aircraft Catastrophic Failure Prevention Research, and 086–110 Aeromedical Research. Capital Investment Plan programs: F–16 FAA William J. Hughes Technical Center Building and Plant Support and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Galaxy Scientific
  Pleasantville, New Jersey
- George Mason University
  Fairfax, Virginia
- University of Massachusetts
  Amherst, Massachusetts
- Case Western Reserve University
  Cleveland, Ohio
- University of Akron
  Akron, Ohio
- University of South Carolina
  Columbia, South Carolina
- Pennsylvania State University
  State College, Pennsylvania
- Rutgers University
  Piscataway, New Jersey
- Cornell University
  Ithaca, New York
- Virginia Polytechnic Institute and State University
  Blacksburg, Virginia
- University of Michigan
  Ann Arbor, Michigan

Products:

- Upgraded fire performance criteria for aircraft cabin materials in future aircraft designs
- Requirements for approving Halon–alternate extinguishing agents
- New fire test standards for hand–held extinguishers and lavatory extinguishers
- Cabin water spray system design for large, double–decked aircraft
- Data for improved fire hardening of fuselage structures
- Fire–safe emergency oxygen system improvements
- Data to support new certification test standards for cargo compartment detectors
- Totally fire-resistant materials for fabricating aircraft cabin interiors
- Microscale heat release rate device for testing flammability of milligram sample quantities to upgrade performance criteria for molded cabin parts and electrical wiring
- Cooperative joint cabin safety research agreement among FAA, Joint Airworthiness Authority (JAA), and Transport Canada (TCA)
- Cabin safety accident/incident data bases
- Cabin safety risk/benefit analysis models
- Passenger evacuation computer models

1996 Accomplishments:

- Demonstrated significant effectiveness of improved thermal–acoustical batting materials in delaying fuselage burnthrough.
- Developed minimum acceptable levels of performance and criteria for Halon replacement lavatory extinguishers.
- Evaluated environmentally acceptable gaseous agents as replacements for Halon 1301 in cargo compartment fire suppression systems.

- Upgraded Aircraft Materials Fire Test Handbook.

- Developed a new flammability test method for airliner blankets.

- Demonstrated non–combustibility of low–cost polysialate/carbon fiber composites with specific strength exceeding steel and aluminum.

- Synthesized new fire–resistant triazine, benzoxazine, phosphine oxide, and phosphazene polymers for aircraft cabin panels. (Patents Pending)

- Completed prototype of microscale heat release rate device. (Patent Pending)

- Demonstrated the concept of using low–cost, nanometer–sized silicate clays to enhance fire resistance of polymeric materials. (Patent Pending)

- Published proceedings of the International Conference On Cabin Safety Research.

1997 Projected Accomplishments:

- Develop minimum acceptable levels of performance and criteria for Halon replacement agents in cargo compartments and hand–held extinguishers.

- Complete full–scale fire tests on materials and concepts for fire hardening an aircraft fuselage against burnthrough.

- Validate microscale heat release device and develop supporting test methodologies.

- Develop nano technology for fire–retardant applications.

- Establish Memorandum of Understanding with the United Kingdom Civil Aviation Authority in cabin safety research and development.

- Establish accident data base.

Planned Activities:

Fire Safety

Materials Fire Safety. In 1998, the development of design guidelines for hardening aircraft fuselages against burnthrough by an external post–crash fuel fire will be completed. Approval of fuselage materials and components will be based on a laboratory burnthrough test that has been validated by full–scale fire tests. From 1998–1999, research will be conducted to examine the need for fire test procedures for the composite fuselage skin planned for the HSCT.

In 1998–2002, research will be conducted to develop fire safety measures and improved fire test requirements for cabin materials in future double–decked aircraft designs such as the VLCT. A full–scale double–decked fuselage testbed will be constructed in 1998. In 1999 full–scale fire tests will be conducted to characterize fire spread into and within the vulnerable upper cabin. These data will be used to evaluate and develop fire stops, improved floor strength, and improved cabin materials fire performance in 2000–2001. In 2002, final design criteria, including fire test requirements, will be developed for the VLCT.

Fire Management. In 1998, engine nacelle fire extinguishing tests will continue on first–generation replacement agents such as hydrofluorocarbons and hydrochlorofluorocarbons approved by the Environmental Protection Agency. Engine nacelle tests on second generation agents such as trifluoromethyl iodide will be conducted in 1998. Also in 1998, the test results will be used to develop engine nacelle certification criteria for approving replacement agents with equivalent effectiveness to Halon 1301.

Cabin water spray research will focus on fire protection in the upper deck of the VLCT. In 2000–2001, full–scale fire tests will be conducted to develop and evaluate a water spray system. In 2002, the test results will be employed to trade off the relative effectiveness of cabin water sprays and improved fire resistant materials during a post–crash fire.

In 1999, tests will be conducted on representative FAA–approved cargo compartment smoke detectors under both flaming and smoldering fire conditions. These tests will evaluate detector response time and sensitivity. Based on this analysis and other relevant compartment parameters, a standardized certification test procedure will be developed in 2000 that measures detector response rates for compliance with existing regulations.

Systems. In 1998, work will begin on evaluating the hazards associated with fires initiated or intensified by emergency oxygen system malfunctions/failures. Actual oxygen systems, including both compressed oxygen and oxygen–generating canisters, will be tested in 1999–2000 to define in–flight fire and post–crash fire hazards. Improved installations, protective measures, and possible system redesigns will be tested and evaluated in 2000–2001. The goal is to develop requirements for fireworthy oxygen system improvements by 2001.

In 1998, support for National Transportation Safety Board aircraft fire investigations will continue, including participation on accident investigation teams, accident material and fluid chemical analysis, and full–scale fire tests to recreate/analyze accident scenarios.

In 1999, a feasibility assessment will be initiated to determine whether an OBIGGS system can be designed to replace present emergency oxygen systems. The feasibility study will be completed in 2001.

Fire Resistant Materials

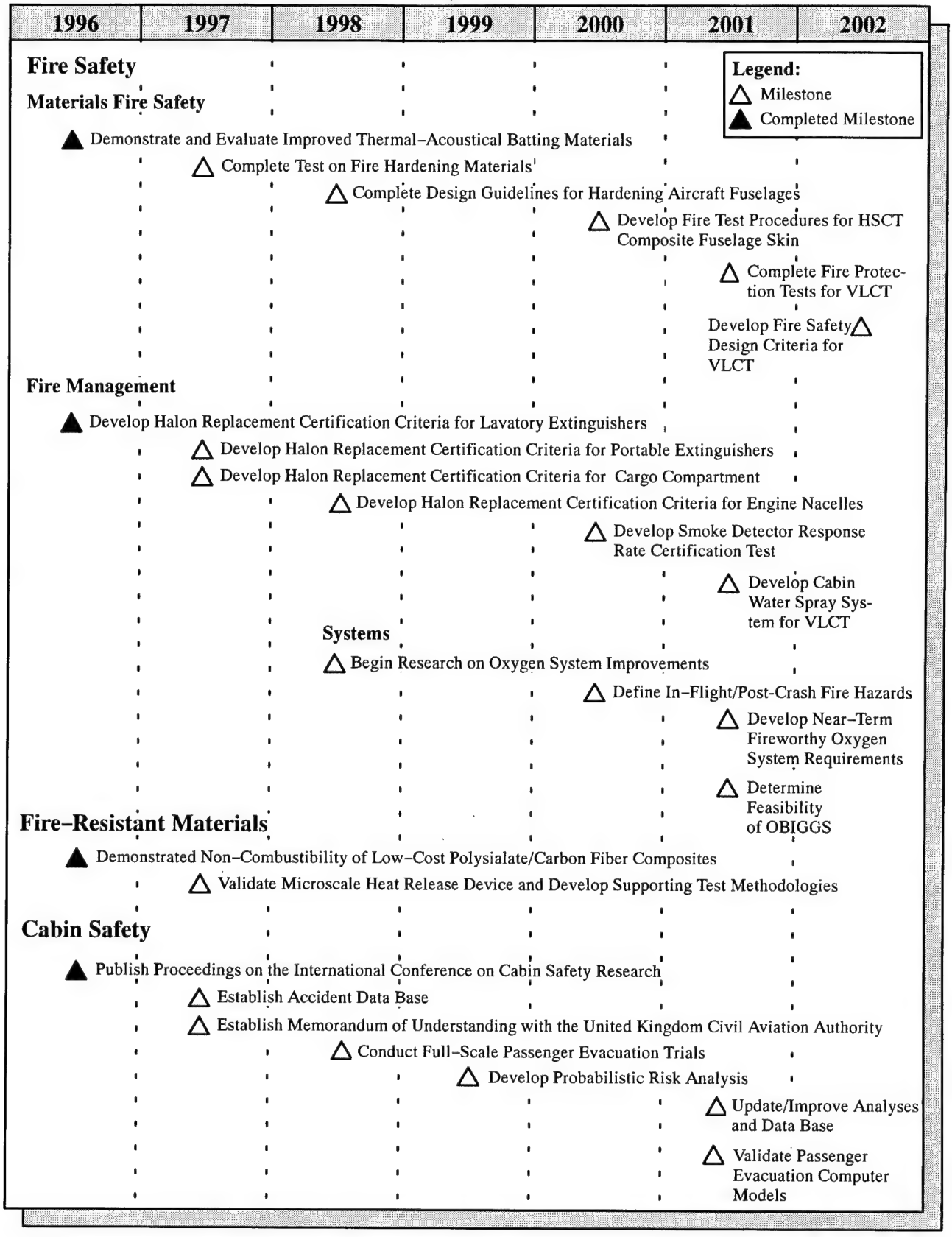
In 1998, work will continue on synthesis of new thermoset and thermoplastic polymers.

Cabin Safety

In 1998, the FAA, JAA, and TCA will establish the management framework for the joint cabin safety research program. Decisionmaking tools such as the cabin safety data bases and the risk/benefit analyses will be continually updated and improved. A probabilistic risk analysis taking into account such factors as fleet growth and mix will be developed for use in 1999.

Full–scale aircraft passenger evacuation trials will be conducted during 1998 to evaluate newly developed computer models. Modifications of these models will continue until final validation in 2001. As confidence is gained in the accuracy of the models, the results will be used in the risk/benefit analyses.

Program 061–110: Fire Research and Safety



062–110 Advanced Materials/Structural Safety

Purpose: This program addresses concerns in two major areas. The first area is advanced materials research, which because of a lack of information and standards on composites and other advanced materials, will focus on acquiring the necessary knowledge to support certification and airworthiness regulations. In addition, this program will promote worldwide standardization and harmonization to enable U.S. industries to compete effectively in the global marketplace. The second area addresses crashworthiness structural safety and ways to increase protection for both occupants and crew during an accident. Research will be conducted to develop and validate test procedures necessary for generating required data. These data are needed to support certification standards, performance specifications, advisory circulars, and other regulatory materials necessary to enhance aircraft crashworthiness and occupant safety.

Approach:

Advanced Materials

Research will focus on technology issues identified in the Aircraft Advanced Materials Research and Development Plan which has been coordinated with the National Research Council of the National Academy of Sciences' findings that can be found in the 1996 New Materials for Next Generation Commercial Transport. Efforts will focus on three technology task areas: materials standardization and test methods, structures, and handbook development. The materials area will investigate the mechanical properties of composites and other advanced materials. The structures area will investigate reliability design, damage tolerance, joints, and other structural or fatigue concerns. Handbooks useful to the FAA, other government agencies, and industry personnel, containing information on design, analysis, inspection, and failure analysis of composite materials will be produced. The data generated in the three tasks will be used by FAA personnel and will form the basis for rulemaking, advisory circulars, and training. Industry will use the data to introduce advanced materials into new designs.

These research efforts will be accomplished in part via the Aviation Research Grant Program, interagency agreements, memorandums of understanding, and the Small Business Innovative Research Program.

Structural Safety

This program establishes a technical data base to generate structural airworthiness and aircraft crashworthiness criteria for both fixed–wing and rotary–wing aircraft. Experimental and analytical research efforts will be developed to create guidelines and performance criteria that ensure continued aircraft structural airworthiness. These efforts will help reduce occupant injuries and fatalities during a crash.

Aircraft crashworthiness includes three areas: airframe structures, aircraft interior, and analytical modeling/computational methods. The airframe structures area will analyze the crash environment, aircraft fuel systems, and structural components to identify and address structural failures. The aircraft interior area will analyze seat/restraint systems and interior furnishings. Analytical modeling/computational methods will be used in developing improved structural, occupant, and seat/restraint systems.

Related Projects: 022–140 General Aviation and Vertical Flight Program, 060–110 Aviation Safety Risk Analysis, 061–110 Fire Research and Safety, 063–110 Propulsion and Fuel Systems, 065–110 Aging Aircraft, 066–110 Aircraft Catastrophic Failure Prevention Research, and 086–110 Aeromedical Research. Capital Investment Plan programs: F–16 FAA William J. Hughes Technical Center Building and Plant

Support and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Wichita State University
  National Institute for Aviation Research
  Wichita, Kansas
- Cranfield University
  Cranfield, United Kingdom
- Massachusetts Institute of Technology
  Cambridge, Massachusetts
- University of California at Los Angeles
  Los Angeles, California
- University of Texas at Arlington
  Arlington, Texas
- Stanford University
  Palo Alto, California
- Northrup/Grumman Corporation
  Hawthorne, California
- Bell Helicopter Textron, Inc.
  Ft. Worth, Texas
- Simula Government Products, Inc.
  Phoenix, Arizona

Products:

- Handbooks for FAA personnel and industry on new composite technologies and manufacturing/inspection analysis techniques
- Data package for certification of structures constructed using advanced materials
- Data package addressing certification criteria for seat/restraint systems
- Technical data packages on crash–resistant auxiliary fuel system designs
- Data package and analysis of rotorcraft exposed to a water impact environment
- Integrated crashworthiness analytical modeling program between the FAA and the United Kingdom
- Data base and methodology for applying damage tolerance analysis in rotorcraft certification
- Methods for determining critical rotorcraft components and principal structural elements and techniques to monitor their operational health

1996 Accomplishments:

- Established test methods for compression loading of composites.
- Published material on composite joints in Military Handbook 17.
- Developed computer programs for reliability assessment of composite aircraft structures.
- Updated Fiber Composite Analysis and Design Handbook – Volume I and Handbook on the Manufacture and Inspection of Composites.
- Completed data base for damage tolerance of flat and curved panels.
- Completed vertical drop testing of a Beechcraft 1900 commuter aircraft fuselage to determine structural dynamic loads.
- Completed composite material aircraft crash test of a Beechcraft Starship at the National Aeronautics and Space Administration (NASA).
- Completed horizontal sled test of a narrow body (B737) fuselage section with overhead stowage bins and auxiliary fuel tank.

- Completed transport category impact analysis and published reports.

- Completed enhancements to seat design/ modeling code.

- Conducted operational evaluation for health and usage monitoring systems (HUMS) during the Atlanta Short Haul Transportation Systems project at the 1996 Summer Olympic games.

1997 Projected Accomplishments:

- Complete characterization of damage accumulation under spectrum loading in composite structures.

- Publish revision of Volume 2 of the Fiber Composite Analysis and Design Handbook.

- Publish reports describing methodology to establish allowable delamination sizes at critical interfaces using developed delamination initiation and growth model.

- Publish primer on reliability assessment for composite airframes.

- Establish delamination growth thresholds for complex structural details.

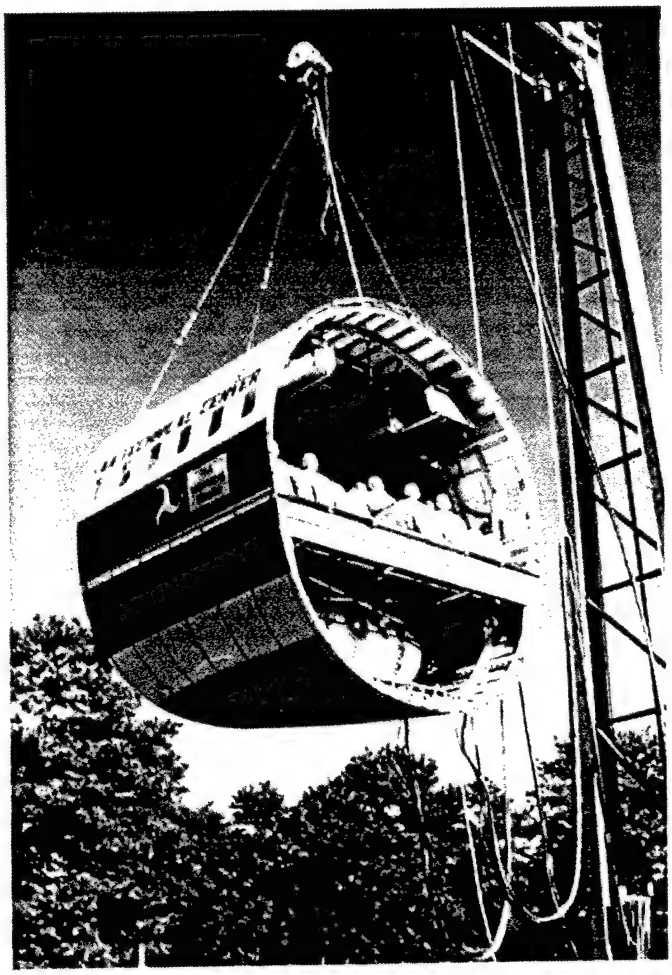
- Establish coordinated crashworthiness analytical modeling program between the FAA and the United Kingdom.

- Provide data for an advisory circular stating the minimum requirements for HUMS for rotorcraft.

- Publish report on critical rotorcraft components to determine health, usage, and life.

- Complete vertical drop test of a narrow body (B737) fuselage section with auxiliary fuel tank.

- Complete vertical drop test of a Shorts 330 commuter aircraft fuselage to determine structural dynamic loads.



Vertical Drop Test of a Boeing 707 Aircraft

Planned Activities:

Advanced Materials

In 1998, work completed on characterization of damage accumulation in composites due to spectrum loading will be used to establish test protocols for aircraft certification and to develop models to predict composite life. Also in 1998, an improved three–dimensional analytical model to predict the response and failure of bolted joints will be developed. Further assessments of composite airframe design based on reliability

methods will continue with a goal to publish guidelines in 1999. Damage tolerance of composite sandwich structures will be addressed starting in 1998. The results of this research, together with previous research on shell structures, will form the basis of the damage tolerance assessment for fuselages to be completed by 2001.

Structural Safety

Testing will be completed in 1998 on a commuter aircraft that utilizes composite materials. This testing will be accomplished through an interagency agreement with NASA.

In 1998, an auxiliary fuselage fuel tank system analysis will be completed to develop recommendations for guidelines. Empennage and fuel tank analyses will be completed in 1999. In 2002, tests and evaluations of crash resistant fuel systems will be completed.

Overhead bin testing for various transport category aircraft configurations will continue through 1998 with completion anticipated for 1999.

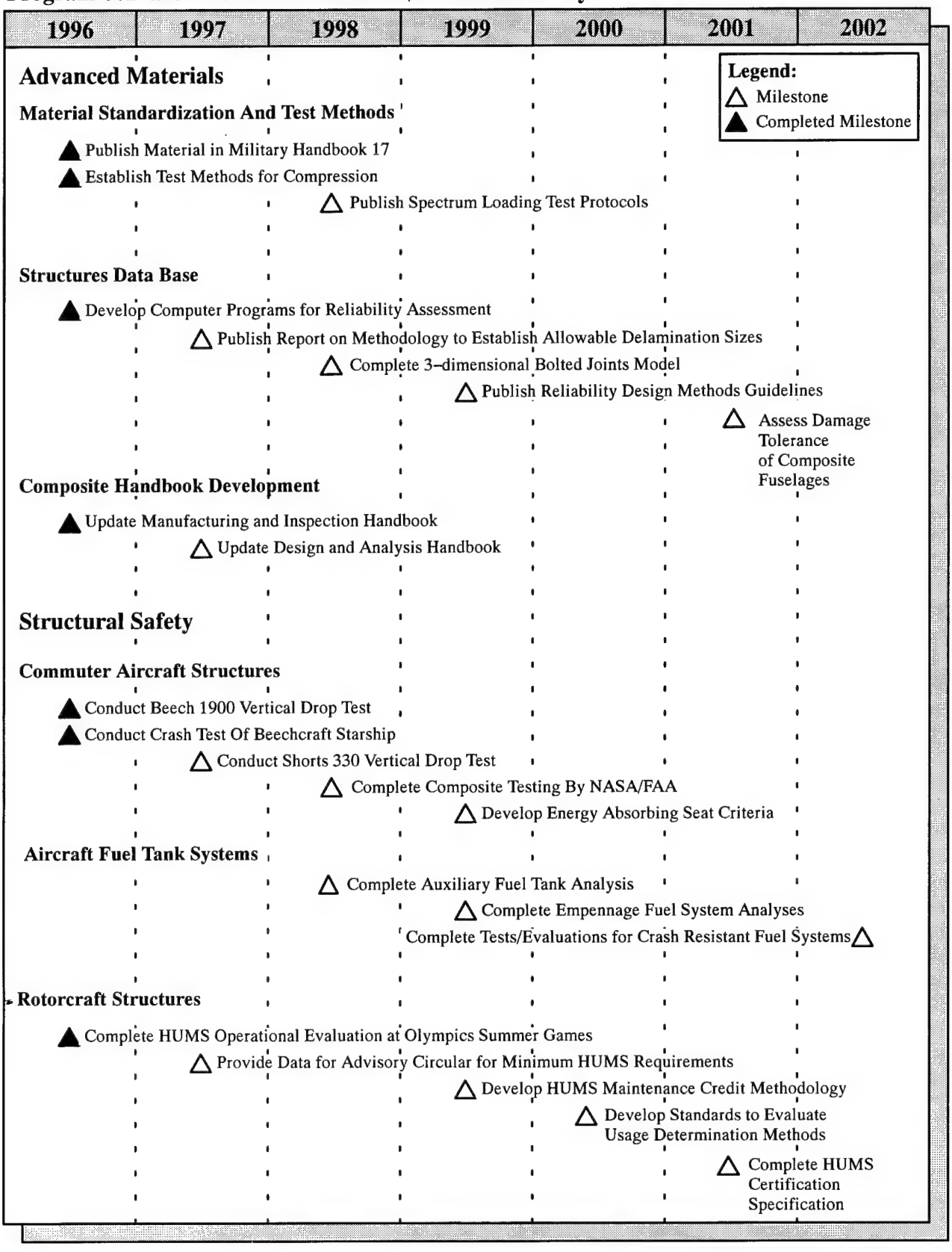
In 1998, testing associated with various commuter cabin safety issues will continue. Data collected from previous drop tests will be used to improve seat designs and models. Energy–absorbing seat criteria will be developed in 1999.

An updated prototype version air accident investigation tool will be developed in 1998 with a completed system in operation by 2002. This effort will complete the joint FAA/United Kingdom research program.

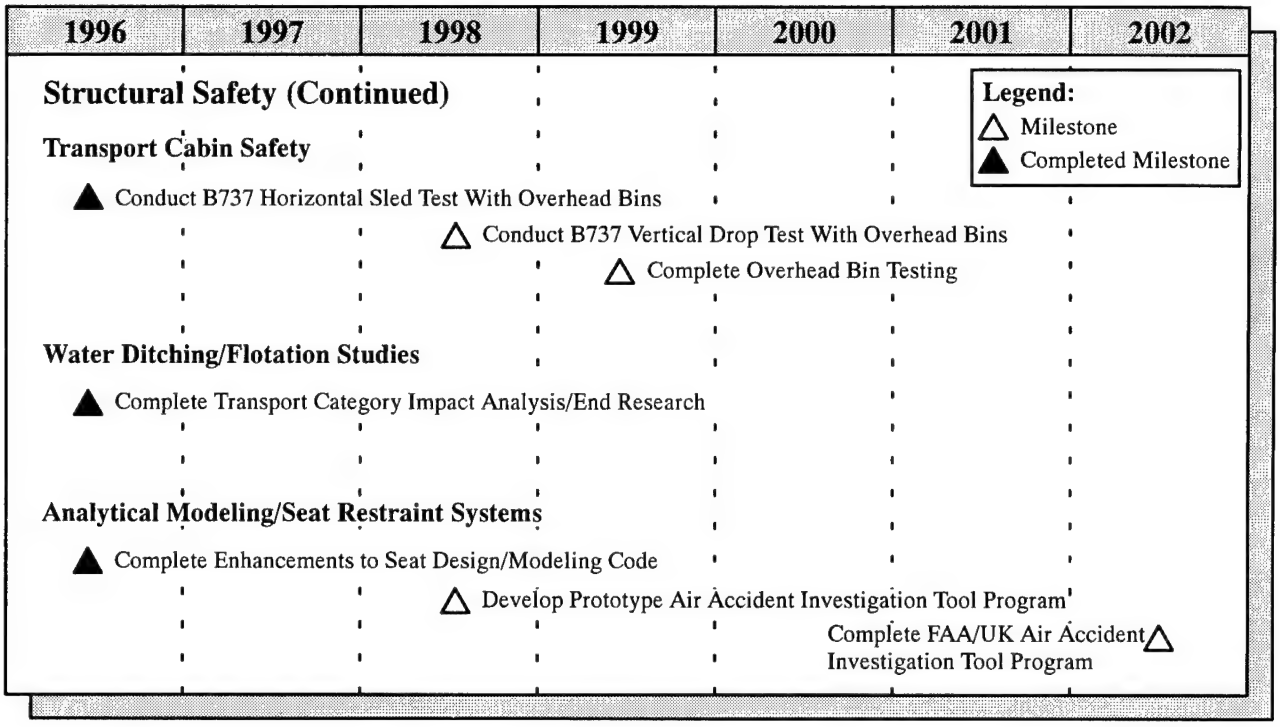
In 1998, work will be initiated to study compliance criteria for passenger and crew egress from rotorcraft in a survivable crash followed by rollover. Research will also begin in the area of test requirements for crash–resistant fuel systems for helicopters.

In 1998, work will continue on the development of a cockpit air bag restraint system which can be used in both rotary– and fixed–wing aircraft. Work will also continue on the development of health and usage monitoring systems to determine optimal inspection/replacement intervals. Efforts to incorporate HUMS into the rotorcraft fleet will continue in 1998. The HUMS maintenance credit methodology to establish inspection/replacement intervals will be developed by 1999. In 2000, standards to evaluate usage determination methods will be developed, with HUMS certification specifications completed in 2001.

Program 062–110: Advanced Materials/Structural Safety



Program 062–110: Advanced Materials/Structural Safety (continued)



063–110 Propulsion and Fuel Systems

Purpose: This program addresses continued airworthiness safety issues of contemporary turbine, piston, and propeller aircraft designs. The safety of FAA certified aircraft will be assured by improving the reliability of high energy rotating components in propulsion systems. Research efforts will also consider the new fuels, materials, and designs employed in the next generation commercial aircraft.

The program is an integral part of a joint FAA and industry strategy to affect a reduction in the occurrence of turbine rotor bursts related to material defects. Superalloys, ceramics, and coatings will permit the engines of the 1990's and beyond to operate at higher temperatures and pressures. However, future engine reliability is a concern as thermal and mechanical fatigue and fracture problems are likely to become more serious. Additionally, environmental and economic issues will force a change in fuels used to power civil aircraft. Performance, safety, and reliability issues will be affected by the transition to these new fuels. This program will provide FAA certification and flight standard offices with the data needed to generate new standards and will develop a data base for industry use to aid in transitioning to the future technologies.

Approach: This program develops criteria, guidelines, and data to support improvements in turbine and piston engine as well as propeller certification requirements. The primary research and development areas are engine and propeller reliability, engine and propeller structural safety, and future fuels safety.

Engine Reliability

Analyses will determine if current standards adequately address engine reliability problems under extreme operating temperatures and pressures. Advanced engine safety and reliability will be continuously assessed as these engines are developed for future transport and general aviation aircraft. External threats to engine reliability will be evaluated, including ingestion of foreign objects such as birds, water, hail, and slush.

The current maturity of digital engine controls and digital flight data recorders, coupled with dramatic advances in the capabilities of portable micro–computers, software, and sensors, provide the basis for the development of low–cost, yet sophisticated, monitoring tools for commercial aircraft operators. The approach will be to develop and apply systems to predict turbine engine rotating component failures and monitor operational history. The system will be able to acquire, calculate, and interpret temperatures, pressures, speeds, fuel flow, vibration, exhaust, oil analysis, air data, nondestructive inspection data, maintenance actions, and critical life usage. From this information, the system will provide appropriate crew notification , analysis display, maintenance documentation, parts life management, maintenance trouble shooting, and failure diagnostics.

Propeller Reliability

This research area will identify and address aging propeller hardware airworthiness safety issues. Research activities will be coordinated with operators, manufacturers, repair shops, other federal agencies, and non–U.S. airworthiness authorities. Research elements involve airworthiness directive and service difficulty report reviews, and advisory and regulatory actions. Anticipated activities include investigations of corrosion–fatigue interactions, flight loads data collection, and development of environmentally friendly corrosion protection materials.

Engine Structural Safety

To address turbine rotor structural integrity, an enhanced rotor material design and life methodology is being developed. This research area features the development of a probabilistically based damage tolerant design tool to augment the commercial aircraft engine safe–life management philosophy. This general purpose design code features a generic interface for the design codes used by the engine manufacturers. The probabilistic code will enable preliminary design analyses including risk and reliability sensitivities. The software and data will be transferred to industry through software documentation, program reviews, and a training workshop.

Current production methods for the titanium alloys used to fabricate critical turbine engine rotating components can produce melt–related defects that can compromise the structural integrity of the finished part. In conjunction with improvements in the current production and inservice nondestructive inspection techniques to detect the defects, the FAA plans to complete the development of an advanced manufacturing process that produces premium grade titanium alloys that will be significantly free of melt–related defects. Plans are to demonstrate commercial production feasibility and establish manufacturing standards for titanium alloys based on this process.

Future Fuels/Safety

The unleaded aviation gasoline development effort is part of a joint industry–government research program managed by the Coordinating Research Council. The FAA participates in the Council's High Octane Unleaded Aviation Gasoline Group. Participants in the program include fuel producers, engine and airframe manufacturers, and user groups. The FAA also participates in the American Society for Testing and Materials task groups that are developing a high octane unleaded aviation gasoline specification and an 82 octane unleaded aviation gasoline specification.

Data will be generated on using unleaded gasolines in aircraft piston engines through ground–based testing, flight tests, and laboratory studies. Specific concerns include: engine performance, fuel consumption, engine knock, hot fuel certification, material compatibility, engine durability, and exhaust emissions. Factors that affect aviation fuel availability will be monitored and research initiated as needed to address both safety and reliability concerns. A future study will investigate the effects of elevated fuel temperatures expected in high–speed civil transports.

Related Projects: 060–110 Aviation Safety Risk Analysis, 061–110 Fire Research and Safety, 062–110 Advanced Materials/Structural Safety, 065–110 Aging Aircraft, and 066–110 Aircraft Catastrophic Failure Prevention Research. Capital Investment Plan programs: F–16 FAA William J. Hughes Technical Center Building and Plant Support and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Southwest Research Institute
  San Antonio, Texas
- General Electric Aircraft Engines
  Evandale, Ohio
- Pratt & Whitney Aircraft
  West Palm Beach, Florida
- Allied Signal Aerospace
  Phoenix, Arizona
- Allison Engine Company
  Indianapolis, Indiana
- Purdue University
  West Lafayette, Indiana
- Georgia Institute of Technology
  Atlanta, Georgia

Products:

- Improved engine rotor durability assessment methods
- Probabilistic engine rotor design code
- Prototype engine diagnostic system hardware and software
- Manufacturing specification for advanced titanium alloy production
- Recommendations for certification standards on general aviation unleaded fuels
- Procedures and software for industry use on octane requirements and engine knock characteristics
- Data on fleet octane requirements and materials found in existing aircraft, including aircraft whose manufacturers are no longer in existence
- Simplified and updated crash resistant fuel systems component test standards to reduce industry certification burden
- Design performance criteria associated with cost effective fuel tank bladder and other crash–resistant fuel tank components
- Environmentally friendly corrosion protection materials for propellers
- Propeller structural design loads spectrum

1996 Accomplishments:

- Completed analysis on titanium rotor anomaly and fatigue and fracture data.
- Completed and published code for determining turbine engine combustion performance when operating with air/water mixtures.

- Published final report on turbine engine diagnostics.
- Completed framework definition for the probabilistic turbine engine rotor design system.
- Completed validation of ground–based procedures for determining octane requirements.
- Initiated inflight and ground evaluations of high octane unleaded aviation gasoline formulas provided by industry.
- Completed testing on four of eight test engines for fleet octane requirement determination.

1997 Projected Accomplishments:

- Demonstrate the probabilistic–based turbine rotor design code (Version 1).
- Validate titanium alloy defect code (Version 1).
- Distribute the compilation and analysis of the titanium alloy vacuum crack growth data.
- Submit initial analysis of propeller airworthiness directive and service difficulty review.
- Complete all engine tests for determining fleet octane requirements.
- Conduct flight tests to correlate ground–based data with actual flight conditions for new aviation fuels.
- Complete tests evaluating ground and in-flight performance of candidate high octane unleaded aviation gasolines submitted by industry.
- Initiate fleet evaluation of candidate fuels.

Planned Activities:

Engine Reliability

In 1998, an engine diagnostic performance criteria will be developed. An advanced fiber optic sensor capability will be demonstrated in 1999. Also in 1999, water ingestion flow separation characterization test results will lead to the development of a design code. A prototype engine diagnostic and monitoring system with expert technology will be demonstrated in 2000, followed in 2001 with integrated flight tests.

Propeller Reliability

Regional/commuter turboprop flight loads data will be collected to develop a propeller structural design loads spectrum in 1998. An evaluation of the maintenance corrosion protection procedure will result in the development of an environmentally friendly corrosion protection material and application process in 1999.

Engine Structural Safety

The research that will lead to enhanced rotor material design and durability will be completed, and an engineering model for crack initiation and growth for selected alloys is expected in 1998. The final probabilistics–based integration rotor design code will be delivered in 1999. A training workshop for this design and durability assessment software will be conducted in late 1999.

By 2000, the advanced manufacturing processes will be established to produce premium quality titanium alloys that are significantly free from melt–related defects. The advanced manufacturing process for titanium alloys demonstration and qualification will be completed in 2001.

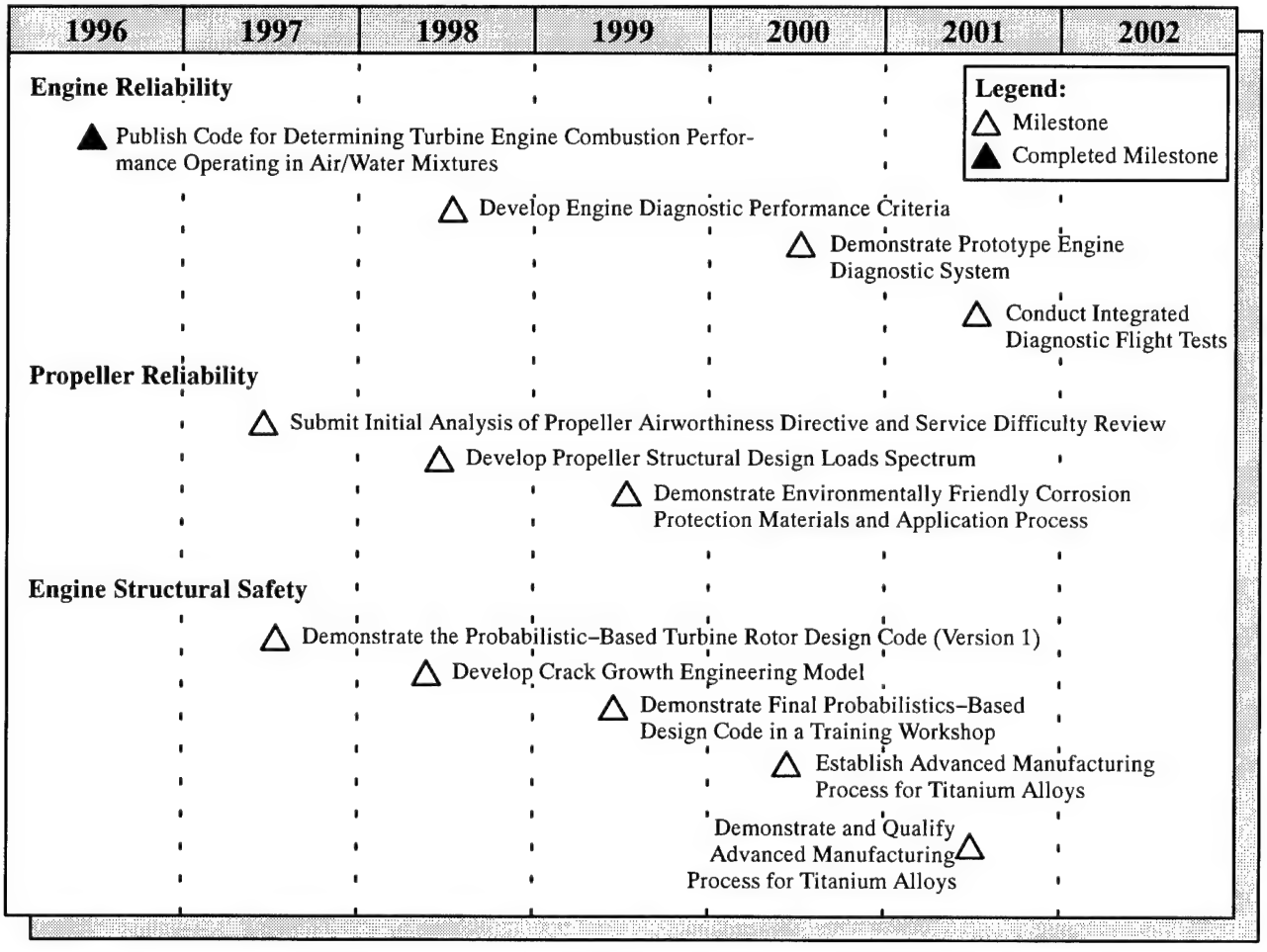
Future Fuels Safety

The unleaded aviation gasoline program was restructured in 1995 due to sponsor and industry requests for specific tests and support. The changes included the establishment of a Coordinating Research Council to manage the overall unleaded aviation gasoline development program, and a two–year effort to measure the existing fleet octane requirement. The industry requested that the FAA act as an impartial evaluator of candidate fuel blends that include proprietary compounds. Proprietary fuel blend testing will continue through 1998. Individual fuel formulas provided by industry will be evaluated in either test cells or in the FAA's test aircraft. Testing to support certification efforts will continue through 1999. The revised schedule calls for draft standards for the high octane unleaded aviation gasoline to be issued to the American Society for Testing and Materials in 1998 and certification testing to begin in 1999. Specification development and certification will be completed in 1999.

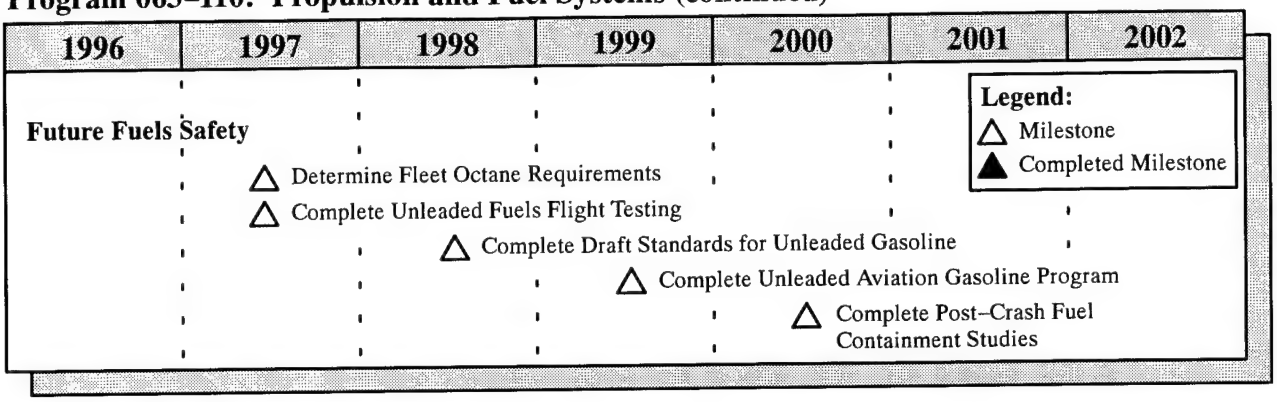
A new research initiative will begin in 1998 to investigate the effects of high temperature on fuel stability, aircraft safety, and engine performance.

From 1998–2000 research will investigate approaches designed to improve post–crash fuel containment. These approaches will lead to potential improved fuel containment by structural modification and possible use of bladders in the inboard section of the aircraft wing tanks. The cost effectiveness of weight penalty, range penalty, and increased safety will be analyzed.

Program 063–110: Propulsion and Fuel Systems



Program 063–110: Propulsion and Fuel Systems (continued)



064–110 Flight Safety/Atmospheric Hazards

Purpose: Research in flight safety/atmospheric hazards has the potential to identify safety problem areas before accidents occur. This program will address new digital technology as well as design and operational issues associated with atmospheric hazards, both natural and man-made, to provide technical data, guidelines, advisory material, and procedures for the regulatory and certification process.

Approach: This program comprises three research areas: aircraft icing, electromagnetic environments, and digital systems validation.

Aircraft Icing

This research area addresses both in–flight icing and ground deicing issues. Efforts will focus on assessing commuter–class aircraft with potential susceptibility to icing-induced tailplane stalls (ICTS). Flight test procedures that facilitate assessing new aircraft susceptibility to ICTS will be developed, leading to certification testing guidelines. Additional efforts will encompass research associated with large, super–cooled droplets and their effects on commuter–class aircraft.

Surface ice detector(s) and related technologies will be assessed, leading to prototype systems for evaluation. In cooperation with NASA, analytical techniques and simulation methodologies will be developed for designing and testing ice protection systems. Technologies associated with current and advanced ground anti/deicing fluids will be investigated to determine optimal application procedures, holdover-time guidelines, and associated aerodynamic effects. Analysis of the worldwide aircraft atmospheric icing environment data will continue and will include large, super–cooled droplets, freezing rain and drizzle, snow, ice crystals, and mixed conditions along with the super-cooled cloud analysis completed earlier.

Electromagnetic Environment

Research efforts in this area will continue to define the adverse effects on advanced technology airframes and systems caused by lightning and high intensity radiated fields (HIRF) and to define the HIRF testing environment. Data currently residing in FAA data bases will support the electromagnetic analysis for HIRF and lightning and will also be available for dissemination

at international symposiums. A cooperative electromagnetic research and development effort was conducted with the United Kingdom, and based on that effort, new protection standards for radomes and fairings will be developed. Lighting strike incident data gathered from participating commercial airlines will be analyzed to determine the adverse interaction effects on highly sensitive electronics in aircraft when composite material is incorporated into the structure. Efforts will be initiated to develop standards which address the portable electronic devices carried onboard aircraft. This program will determine a more reliable and cost–effective technique for certifying flight–critical systems. Research is conducted in conjunction with the Department of Energy Idaho National Engineering Laboratories and the Department of Defense Naval Air Warfare Center.

Digital Systems Validation

Digital systems validation research will address certification and airworthiness standards and techniques as they relate to emerging, highly complex, software–based digital flight controls and avionic systems. Technical data and information relative to this new technology will help FAA certification/airworthiness specialists keep abreast of the latest avionics software and hardware developments and their potential applications in aircraft. Primary emphasis will be on flight safety issues pertaining to the application of this technology to flight–critical and flight–essential systems. This program will evaluate current system safety assessment methods and modify or develop new techniques as required. Certification techniques associated with fly–by–light/power–by–wire technology will also be addressed. This work will be accomplished in coordination with NASA.

Related Projects: 022–140 General Aviation and Vertical Flight Program, 041–110 Aviation Weather Analysis and Forecasting, 060–110 Aviation Safety Risk Analysis, 061–110 Fire Research and Safety, 065–110 Aging Aircraft, and 075–110 Aircraft Hardening. Capital Investment Plan programs: F–16 FAA William J. Hughes Technical Center Building and Plant Support and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Galaxy Scientific Corporation
  Pleasantville, New Jersey
- Robotic Vision Systems, Inc.
  Haupauge, New York
- Nichols Research Corporation
  Huntsville, Alabama
- University of Illinois at Urbana– Champagne
  Urbana–Champagne, Illinois
- University of Quebec at Chicoutimi
  Quebec, Canada

Products:

- Pilot's Guide to Aircraft Ground Deicing advisory circular
- Report on field measurements for advanced anti/deicing fluid time of effectiveness
- Aircraft surface ice detection technologies and systems
- Holdover times for Type II advanced deicing/anti–icing fluids
- Report on wind tunnel testing of ICTS with and without ice shapes
- Report on representative values of freezing rain and freezing drizzle
- Characterization of the large, super–cooled droplet icing atmospheric environment
- High Intensity Radiated Fields Handbook

- Advisory material addressing portable electronic devices data base
- Electromagnetic threat definition, development, and validation
- Lightning advisory circular and user manual updates
- HIRF advisory circular and user manual updates
- Tutorials/chapters for the Digital Systems Validation Handbook
- Technical report on flight critical digital systems technology studies for assessment and development of airworthiness and certification methods
- Avionics software development guidelines report and data package

1996 Accomplishments:

- Evaluated time of effectiveness for recently developed anti/deicing fluids under various freezing precipitation conditions.
- Completed flight testing on ICTS susceptibility.
- Issued holdover times guidelines for Type II advanced deicing/anti–icing fluids.
- Published report on wind tunnel testing of ICTS with and without ice shapes.
- Published report on representative values of freezing rain and freezing drizzle.
- Published expanded and updated version of the FAA research and development electromagnetic data base.
- Published Digital Systems Validation Handbook – Volume III, Chapters 1 and 2.
- Completed data collection and assessment for definition of rotorcraft HIRF environment.

1997 Projected Accomplishments:

- Publish report on polarized radiation–based aircraft surface ice detector technology.
- Complete flight testing of ICTS susceptibility.
- Issue holdover times guidelines for new, advanced Type IV deicing/anti–icing fluids.
- Publish FAA/NASA final report on commuter aircraft ICTS.
- Complete bench testing of full authority digital engine controller for a production helicopter.
- Publish six chapters of the HIRF handbook.
- Publish update to Aircraft Icing Handbook incorporating information on large droplet icing, icing codes, and ice detection technologies.

Planned Activities:

Aircraft Icing

In 1998, efforts will continue to define and characterize the large, super–cooled droplet environment and to assess their effects on selected airfoils and aircraft designs. Analysis and development work on aircraft–mounted surface ice detection technologies will continue through 2001. Research will continue on near–infrared area coverage sensors and integrated ultrasonic capacitive–based sensors in 1998–1999. In 1999, a decision will be made on which technology to develop into a hand held and an aircraft mounted surface ice detection area coverage system for implementation in 2001. Also during this period, special emphasis will be placed on cooperative efforts for development of remote sensor

technologies to detect large, super–cooled (SLD) droplet icing conditions from a distance.

In 1998, new and advanced deicing fluids will continue to be evaluated for their time of effectiveness and their aerodynamic performance. These evaluations will lead to updated holdover-times guidelines in 1999. Efforts will continue in 1998 for the development of laboratory testing methodologies to derive holdover times for newly qualified advanced fluids, thus reducing the time and effort currently required for in situ testing.

In 1998, anti–icing research in this program will provide a technical report on ice phobic technologies such as ice shedding materials and coatings, and low energy anti–icing techniques. In 1999, a decision will be made on which technology to pursue in the development of an inflight sensor for detection of SLD icing at a distance. Further research will lead to publishing advisory material to facilitate icing certification of aircraft in 2000, and developing universal coverage surface ice detectors in 2001.

Additionally, newer aircraft such as tiltrotor/ powered–lift, supersonic transport, and the national aerospace plane will require innovative ice protection technologies and attendant innovative approaches for certification.

Electromagnetic Environment

In 1998, data from HIRF and lightning protection advisory material and users manuals will be analyzed, and if appropriate, incorporated into the rulemaking process. Research from this program will be presented to the international electromagnetic community. Also in 1998, a HIRF digital avionics upset report will be published, and the HIRF Handbook will be updated with two additional chapters. Research will continue to determine a means of in situ identification of potential hazards caused by portable electronics devices. A report will be published in 1999, and new standards will be developed in 2000.

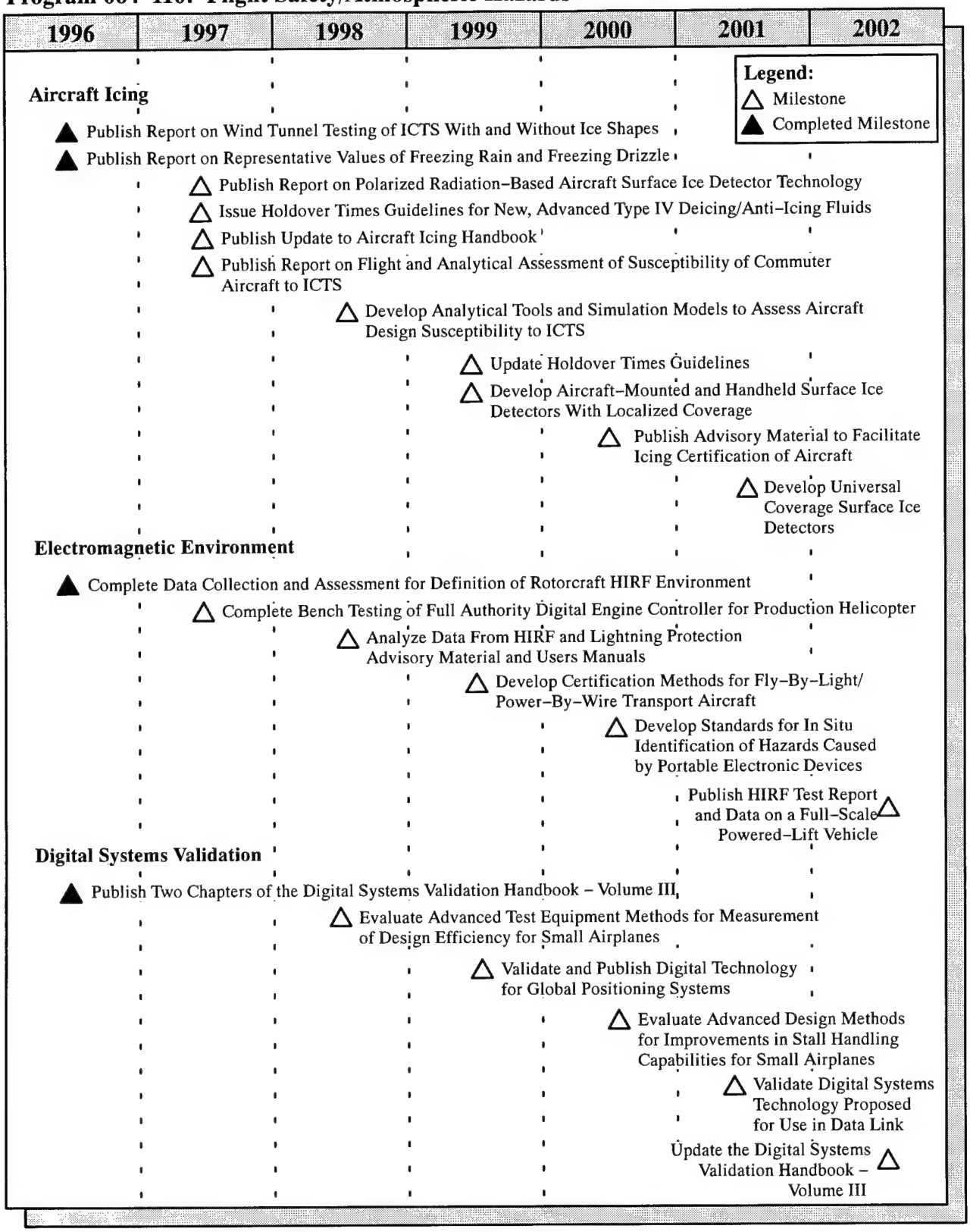
In 1999, an emergency medical equipment HIRF analysis report will be published. Also in 1999, certification methods for fly–by–light/power–by–wire transport aircraft will be developed.

In 2000, fly–by–wire electromagnetic environment studies will be completed. In 2001, an effort will be initiated to review lightning data bases to determine if the current standards used for the direct and indirect effects during certification are appropriate. In 2002, a full–scale powered–lift vehicle will be tested for electromagnetic interference, followed by publication of a HIRF test report and data.

Digital Systems Validation

Research will continue in 1998 to address airworthiness and certification issues relative to constantly emerging technology. Guidelines for complex avionics software development will be assessed. Also in 1998, an evaluation of advanced test equipment and methods for measurement of design efficiency for small airplanes will be published. In 1999, digital technology for global positioning systems will be validated and published. In 2000, criteria will be developed for certification credit based on software service history. Also in 2000, an evaluation of advanced design methods for improvements in stall handling capabilities of new and existing small airplanes will be completed and results published. In 2000, small airplane whirl–mode flutter evaluation techniques will be developed and assessed. In 2001, digital systems technology proposed for use in data link will be validated, and in 2002, the Digital Systems Validation Handbook – Volume III will be updated.

Program 064–110: Flight Safety/Atmospheric Hazards



065–110 Aging Aircraft

Purpose: Aging airframe structures have shown increasing susceptibility to widespread fatigue damage and corrosion that could pose a threat to their structural integrity. Instances of structural failures point to the need for increased reliability in inspection methods. This research effort will ensure safety by developing the means for evaluating and reducing the risks associated with aging aircraft structures. The various research activities will also include technology transfer of technical material and knowledge to industry and foreign regulatory agencies.

Approach:

To address aging aircraft structural design problems, improved methodologies and test data are needed. Models and data will be developed to correlate service experiences with test and analysis results. Design alternatives that delay or eliminate widespread fatigue damage will be identified. To provide passengers with the most consistent level of safety practical, whether service is provided by transport or commuter category airplanes, a methodology for developing supplemental inspection documents will be established for commuter airplanes in scheduled service.

The corrosion effects on fatigue and fracture will be quantified and evaluated. Analytical fracture models resulting from this work will be used as a basis for rulemaking. Means for evaluating the effect of single and multiple repairs on airframe structural integrity will be developed. This work will benefit independent repair stations and smaller air carriers. Modern flight and ground load data collection systems have been developed and installed on both small and large transports. Flight usage profiles and structural loading histories will be determined for the current fleet. Technical data to assess the continued applicability of load–related regulations will be generated.

Improvements in maintenance practices and training, as related to repair and corrosion control, will be developed and offered to heighten awareness of structural degradation modes among the aviation community, particularly the aviation maintenance technicians and inspectors. Increased emphasis will be placed on maintenance human factors and human performance. A job task analysis will be conducted to identify critical maintenance and inspection tasks and establish a basis for training updates. An analysis of current communication processes will be conducted to identify difficulties and to establish guidelines to improve technical documents to ensure that the information is interpreted as intended.

Existing and emerging nondestructive inspection equipment and methods will be evaluated for their capability to detect material defects. Prospective technologies are being developed that offer improvements in detectability, reliability, ruggedness, automation, human performance, and cost. Prototype systems will be developed and tested. The most promising technologies will lead to cooperative research and development agreements with industry for technology transfer. Additionally, advisory material will be developed for inspection facilities, equipment, and personnel.

Related Projects: 060–110 Aviation Safety Risk Analysis, 062–110 Advanced Materials/Structural Safety, 063–110 Propulsion and Fuel Systems, 064–110 Flight Safety/Atmospheric Hazards, and 075–110 Aircraft Hardening. Capital Investment Plan programs: F–16 FAA William J. Hughes Technical Center Building and Plant Support and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Center for Aviation Systems Reliability: Iowa State University, Wayne State University, Northwestern University, and Tuskegee University
- Sandia National Laboratories
  Albuquerque, New Mexico
- University of Washington
  Seattle, Washington
- University of Dayton Research Institute
  Dayton, Ohio
- Embry Riddle Aeronautical University
  Daytona Beach, Florida
- FAA Center of Excellence in Computational Modeling of Aircraft Structures: Georgia Institute of Technology and Rutgers University
- Battelle Institute
  Columbus, Ohio
- General Electric Aircraft Engines
  Evandale, Ohio
- Pratt & Whitney
  East Hartford, Connecticut
- Allied Signal Aerospace
  Phoenix, Arizona
- Cessna Aircraft
  Wichita, Kansas
- Fairchild Aircraft
  San Antonio, Texas
- The New Piper Aircraft
  Vero Beach, Florida

Products:

- Damage tolerance training materials for FAA certification personnel
- A maintenance and inspection management program that will be used to derive regulatory documents for commercial pressurized engine cases
- Analytical tools and models to assess commuter and transport aircraft structural integrity and repairs
- Technical data used to formulate the Special Federal Airworthiness Regulation and advisory circulars on widespread fatigue damage and the corrosion fatigue interaction
- Technical data that can be used for design, certification, and airframe life assessment for flight and ground loads encountered by transport and commuter airplanes
- Training tools, aids, and material for repair, maintenance, and inspection personnel
- Data base on airframe maintenance, inspection, repair and corrosion control procedures, and aircraft engine testing
- Inspection systems for flaw detection in airframe structures and engines for compliance certification
- Supplemental inspection documents for commuter category airplanes to provide for the continuing airworthiness of the commuter fleet

1996 Accomplishments:

- Developed an analytical tool for designing and analyzing airplane fuselage skin repairs.
- Published technical reports on experimental tests of large flat panels and curved fuselage panels.
- Completed reliability assessment of various visual inspection tasks.
- Completed report on development and beta–site testing of emerging nondestructive inspection devices, including thermal inspection techniques, pulsed eddy current methods, enhanced visual systems, and signal processing algorithms.
- Completed development and beta–site testing of an improved inspection system for titanium billets.
- Published technical report on flight load usage data for large transport aircraft.
- Conducted video landing parameter survey at one major commercial airport.
- Installed 12 optical disk recorders on B–737 and MD–80 aircraft.
- Developed user–friendly computer tool for determining Federal Aviation Regulation 23 design and fatigue loads from basic geometry information.
- Completed the technical interface between flight loads research and the Flight Operational Quality Assurance program.
- Developed an analytical model on fretting fatigue.
- Completed an advisory circular on the development of a corrosion control program for commuter aircraft.
- Developed weighted job task definitions for aviation maintenance technicians.
- Developed guidelines for improving the communication of technical information.
- Developed a strategic plan for aviation maintenance human performance to integrate and coordinate human factors and human performance across flight standards, aviation medicine, and aviation research.

1997 Projected Accomplishments:

- Complete supplemental inspection document for the Cessna 402 airplane.
- Develop a prototype eddy current array probe and a portable eddy current scanner for in–service engine component inspection.
- Develop an analytical tool to design and analyze complex fuselage repairs.
- Develop stress–intensity factor solutions for part–through cracks at countersunk rivet holes under tension, bending, and pin loading.
- Develop an engineering PC–based tool to predict residual strength of stiffened aircraft fuselage structures with multiple site damage.
- Conduct video landing survey for commuter category aircraft.
- Extend ground–load methodology to commuter aircraft.
- Install 12 additional optical disk recorders in large commercial aircraft.
- Complete development of a software tool for validating aircraft fuselage inspection systems.

- Develop maintenance technician resource management phase I, awareness, training course and deliver introductory handbook.

- Develop prototype maintenance error decision analysis data base and analysis tools.

- Evaluate current aviation maintenance technician training curriculums.

- Complete Inspection Reliability Data and Analysis Handbook.

Planned Activities:

Residual Strength Analysis

In 1998, testing of full–scale aircraft panels will continue to determine multi–site damage effects on residual strength, and residual strength predictive methodologies will be validated. Methodologies to predict widespread fatigue damage will be integrated into an overall risk assessment methodology in 1998. In 1999, the analytical methodologies will be extended to structural modifications and corrective actions.

Factors affecting fatigue and airframe design fracture resistance will be studied in 1998, leading to design guidelines for widespread fatigue damage in 2002.

From 1998–2000, development work will continue on a global risk analysis model that predicts residual strength of aircraft structures subjected to widespread fatigue damage. A prototype will be developed in 1998 for testing and evaluation through 2000.

Structural Integrity of Commuters

From 1998 through 2000, supplemental inspection documents will be developed for additional airplane models in the commuter fleet. These supplemental inspection documents may be used to establish supplemental inspection programs for commuter category aircraft using damage tolerance methods.

Maintenance and Repair

A PC–based repair tool addressing aircraft structural modifications will be extended to repairs of commuter aircraft starting in 1998. Completion of the enhancements to the repairs analysis tool is planned for 2000.

In 1998, repair station housing and equipment criteria will be developed for airframe and engine structural repairs. Additionally, a data package leading to an advisory circular on engine test cell data correlation will be completed to eliminate anomalies between individual repair stations.

Flight and Ground Loads

From 1998–2002, flight and ground loads data collection will continue for structural analysis programs. In 1998, six solid state recorders will be installed on both Beechcraft 1900D and Fairchild Metro III airplanes. Four video landing parameter surveys will have been completed by 1998 with a fifth survey planned in 1999. A computer methodology will be developed in 1998 to determine structural design and fatigue loads from basic airframe data on small airplanes. This methodology, previously extended to commuter aircraft, will be validated in 2000, and refined for industry use in 2001.

Engine Life Predictions

In 1998, development will continue on a data base for aircraft engine materials to formulate crack growth–based methodologies. The methodologies will be developed by 2000 to derive inspection and maintenance requirements for engine pressurized static cases. These methodologies will be tested and validated in 2002 at which time engine life prediction research will be completed.

Inspection Technology

Research on validating and assessing inspection techniques will continue through 2004 at the Aging Aircraft Nondestructive Inspection Validation Center. In 1998 a subset of emerging flaw detection devices will be selected for further development and validation. Emphasis will be placed on small crack detection and detection of subsurface and second or third layer flaws. Validation of the devices will continue through 2000.

Engine Inspection

Eddy current methods for inspecting engine material and components in service will be developed in 1998 and validated in 1999. Ultrasonic methods for inspecting engine material and components during production will be developed in 1998 and validated in 1999. Also in 1999, research will begin on developing fluorescent penetration inspection improvements that will detect smaller flaws with greater reliability.

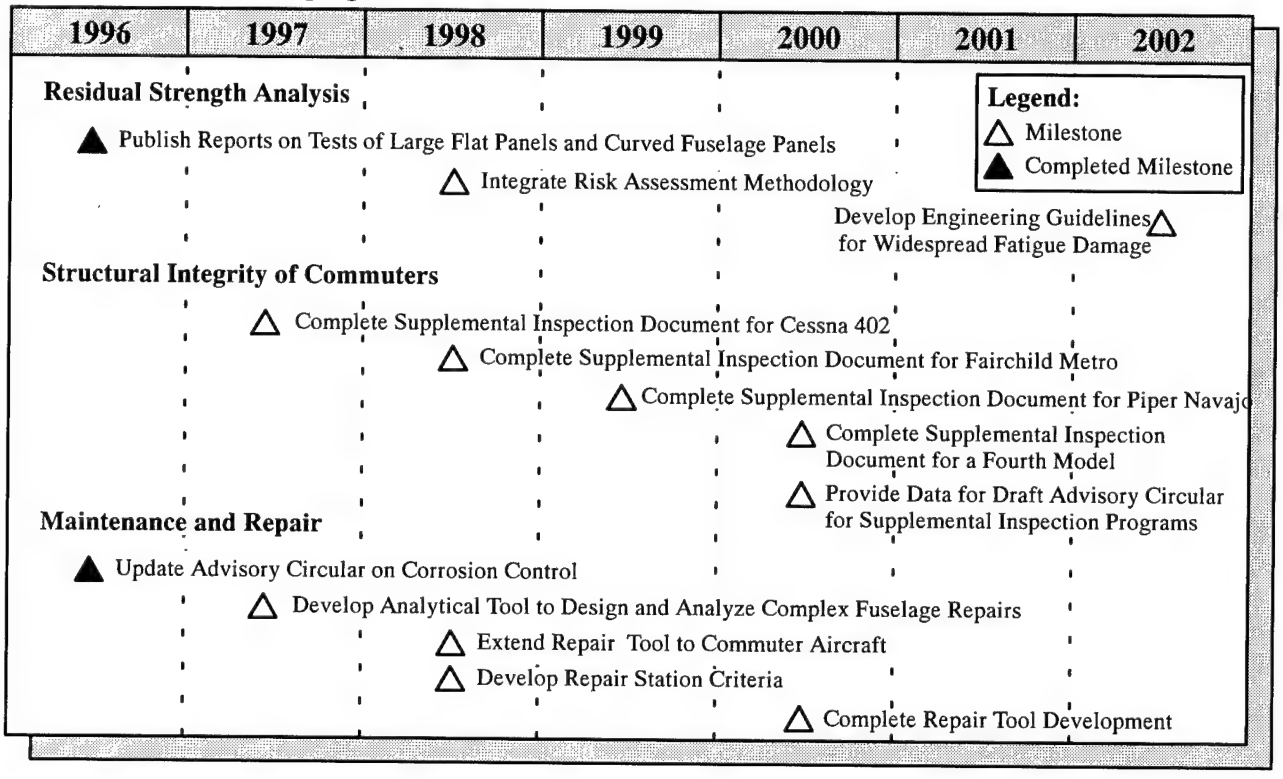
Human Performance

Updated weighted job task definitions will be used to develop aviation specialist qualifications and standards in 1998. Also in 1998, the maintenance technician resource management phase 2, operational, training course will be developed, and the evaluation and report of noncertified training for aviation maintenance technicians will be delivered.

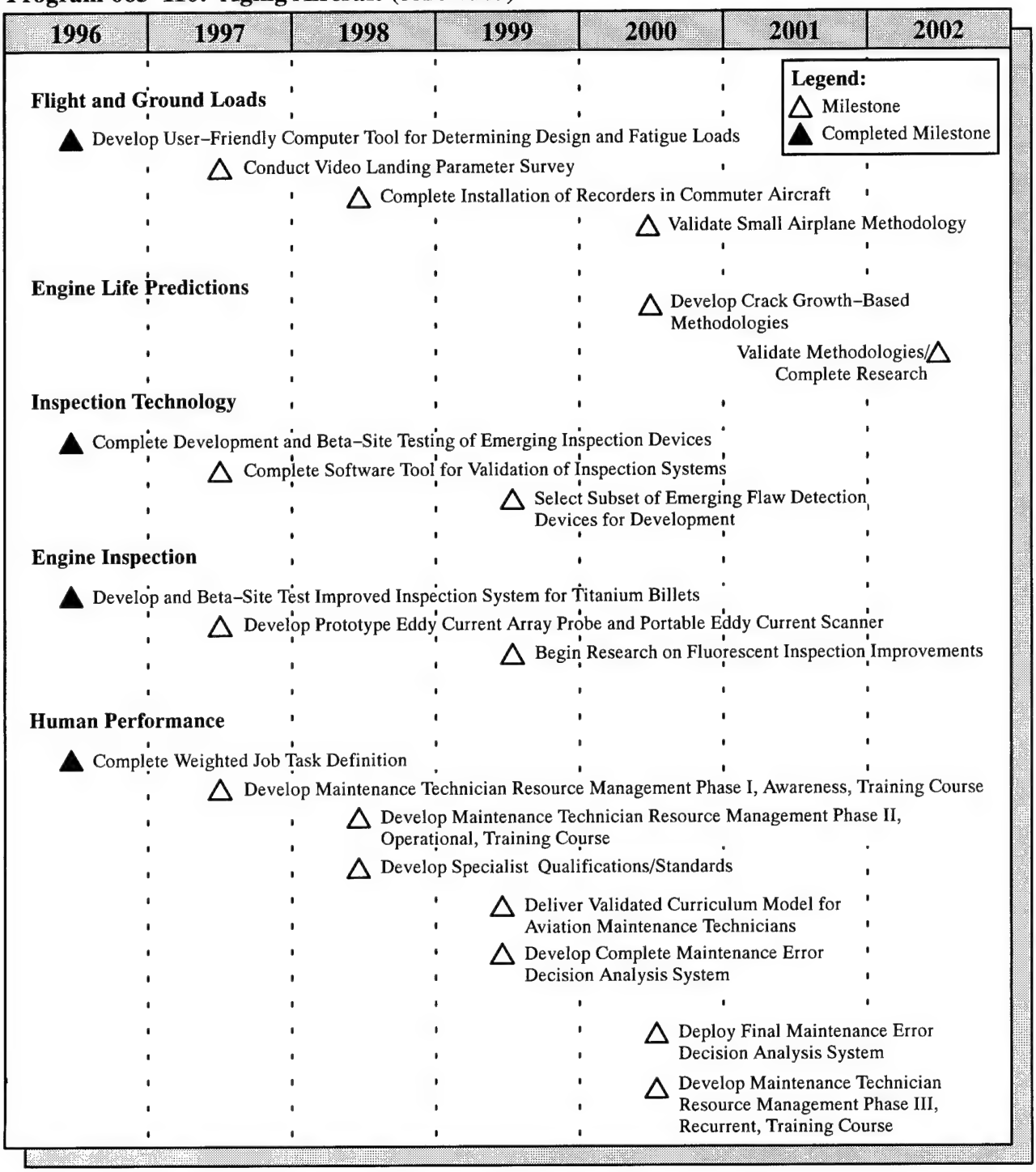
In 1999, the complete maintenance error decision analysis system will be developed, and the validated curriculum model for aviation maintenance technicians will be delivered.

In 2000, the maintenance technician resource management phase 3, recurrent, training course will be developed, and the maintenance error decision analysis final system will be deployed. Also in 2000, a model for the certification process of aviation maintenance technicians will be deployed.

Program 065–110: Aging Aircraft



Program 065–110: Aging Aircraft (continued)



066–110 Aircraft Catastrophic Failure Prevention Research

Purpose: This program will establish and direct a research effort to identify, reduce, and prevent aircraft system problems that could result in catastrophic aircraft failures. This failure prevention research will reduce catastrophic accident risks and the number of hull losses, injuries, and fatalities. Information developed from this program will be disseminated to the aircraft industry on a regular basis. This research is required by Title IX of the Omnibus Budget Reconciliation Act of 1990 (Public Law 101–508), "Aircraft Catastrophic Failure Prevention Research Program."

Approach: This program will conduct research to develop methodologies that characterize and assess the risks associated with potentially catastrophic aircraft hardware, software, and operational problems. Further research will evaluate, test, and develop technologies to prevent and minimize these hazards. Technology transfer will utilize the technical bases of industry, academia, non–profit laboratories, and other government agencies. The research will address failure scenarios that involve the interaction of several aircraft systems as well as more specific failure types such as turbine engine/auxiliary power unit, fuselage structural, and damaged or failed flight control systems.

Certification/Regulation Investigations

A study of accidents and incidents and their relationships to current regulations will be performed. This study will define areas within the federal aviation regulations and advisory materials that need revision. The various methods used to demonstrate compliance with regulations will also be analyzed. The appropriate use of reliability analysis, comparison with similar systems, simulation and flight testing within a certification program will be defined in the form of guidelines for certification engineers.

Turbine Engine Failures

A failure in turbine engine and auxiliary power unit rotating components can be a serious safety hazard to critical aircraft systems because high energy fragments can be released. The traditional approach to minimize these hazards is to isolate individual engines and auxiliary power units from other engines and flight critical systems. More effective containment or protective shields are an underutilized approach due to weight and complexity penalties. This program will determine high energy fragment characterization and evaluate protective shield material technology. A comprehensive advanced lightweight material technology review will be conducted, and new material concepts will be developed for absorbing high kinetic energy fragments in the largest turbofan engines. Further efforts will provide a methodology to determine catastrophic failure probability and risk assessment. This methodology will be used to develop an analytical model of uncontained fragments from gas turbine engine and auxiliary power unit rotating component failures. This model will assist in assessing the catastrophic failure risk in current and future designs by identifying critical systems and structures needing protection.

In addition to turbine engine failure, accidents may be caused by inappropriate crew reactions to engine failure annunciation systems. Engine–plus–crew error events begin with a potentially manageable engine malfunction or failure that may be compounded by inappropriate crew response. These particular events are responsible for hull losses, including fatal accidents, at a rate of one per ten million flights, and are the leading cause of propulsion system related accidents.

The reliability of engines has improved to the point where a significant in–flight event may not occur in the entire career of many pilots. For this

reason, the inability of some pilots to correctly assess that an engine failure has or has not occurred should be considered in accident investigations. To alleviate this potential problem, an improved engine failure annunciation system may be needed. Before regulations and advisory material can be developed, a cooperative study is needed to review the data, define contributing factors for accidents, and outline proposals for corrective action. Research will consider current engine failure crew annunciation systems, upgraded simulators for training, and enhanced crew training for recognition of engine failures.

Structural Failures

Research in this area will be directed toward advanced means to predict and prevent catastrophic structural failures on future commercial transport aircraft. Research will also be directed toward advanced means to predict, with known probability, aircraft structural loads during the aircraft design phase. Large, high–bypass engines induce significant loads on aircraft after loss of blades. The same loads can be induced by bearing failures, and in the case of propeller–driven aircraft, by the loss of a blade. These loads are caused by the torque and unbalance at the time of blade loss and continuing unbalanced loads from a windmilling condition. The latter condition normally would exist until completion of the flight, and can have a significant effect on structure, systems, and the flight crew. A research and development effort is needed to develop and validate analysis methods for the structural dynamic response of an airplane to unbalanced engine conditions.

Flight Control Failures

This research area will address specialized technology fields that concentrate on preventing catastrophic flight control failure after an in–flight accident or incident. Research will assess what failed–mode flight control options are practical for any control failure case to ensure continued safe flight and landing. Research in this area will concentrate on studies that include areas such as: substitute, alternate, and reconfigurable control systems; flying qualities criteria; stability and control; situational awareness; and human factors. A program of modeling analysis simulation and variable stability aircraft flight tests is planned to provide technology that could be beneficial in failed–mode flight control situations. The proposed approach will test both aerodynamic aspects and aircraft stability and control. This approach will: develop technology to improve aircrew emergency procedures; provide aircrew training that simulates damaged aircraft handling qualities; conduct research on damaged flight control airworthiness issues; provide a real–time flight control cockpit advisory system; design and test innovative failure–tolerant flight control systems; and establish metrics to quantify and compare the robustness and failure tolerance of flight control systems.

Related Projects: 060–110 Aviation Safety Risk Analysis, 061–110 Fire Research and Safety, 062–110 Advanced Materials/Structural Safety, 063–110 Propulsion and Fuel Systems, and 075–110 Aircraft Hardening. Capital Investment Plan programs: F–16 FAA William J. Hughes Technical Center Building and Plant Support and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Princeton University
  Princeton, New Jersey

- Crown Communications, Inc.
  Washington, D.C.

- Lawrence Livermore National Laboratory
  Palo Alto, California

Products:

- Advanced materials suitable for airframe barriers

- Guidelines establishing appropriate regulation compliance methods
- Uncontained engine debris characterization
- Model of uncontained debris from turbine engine rotating component failures
- Aircrew emergency procedures and new systems for damaged or failed flight control systems
- Risk assessment analysis methodology tools
- Failed–mode flying qualities assessment system and situational awareness/cockpit resource management procedures

1996 Accomplishments:

- Completed predictive techniques and analysis of gust loading conditions and airworthiness requirements for maximum gust loads.
- Completed report on stochastic modeling of antisymmetric buffet loads on horizontal stabilizers.
- Completed small turbine engine containment tests.
- Completed high temperature containment ring tests.
- Completed analytical study of uncontained turbine rotor fragment penetration threat to aircraft wing fuel tanks.
- Completed Phase I development of an aircraft probabilistic risk assessment methodology.

1997 Projected Accomplishments:

- Complete uncontained turbine rotor fragment characterization.
- Refine vulnerability assessment tool.
- Determine applicable advanced turbine rotor fragment barrier materials.
- Complete accident/incident and regulatory review.
- Complete risk assessment guidelines for certification engineers.
- Initiate model development of uncontained debris from turbine engine rotating component failures.
- Initiate cooperative agreement with NASA for intelligent damage adaptive control system.
- Initiate research on engine–plus–crew error problem.

Planned Activities:

Certification/Regulation Investigations

In 1998, an intensive investigation of regulations, advisory materials, and certification techniques based on the results of the aircraft accident, incident, and regulation study will begin. Areas in need of revision will be studied thoroughly, and modifications will be proposed from 1998 through 2001.

Turbine Engine Failures

In 1998, vulnerability assessment codes will be developed to allow methodical determination of the effects of uncontained engine debris on the airframe.

In 1999, a prototype computational model will be developed to simulate rotor fragment dispersal, barrier penetration, and aircraft damage. Model validation will take place through 2000, with final development expected by 2001. In 1998,

simulator training issues on the engine–plus–crew error problem will be examined and recommendations will be made. This research will culminate in 2000 with the simulator testing of an engine failure warning system developed with the cooperation of industry.

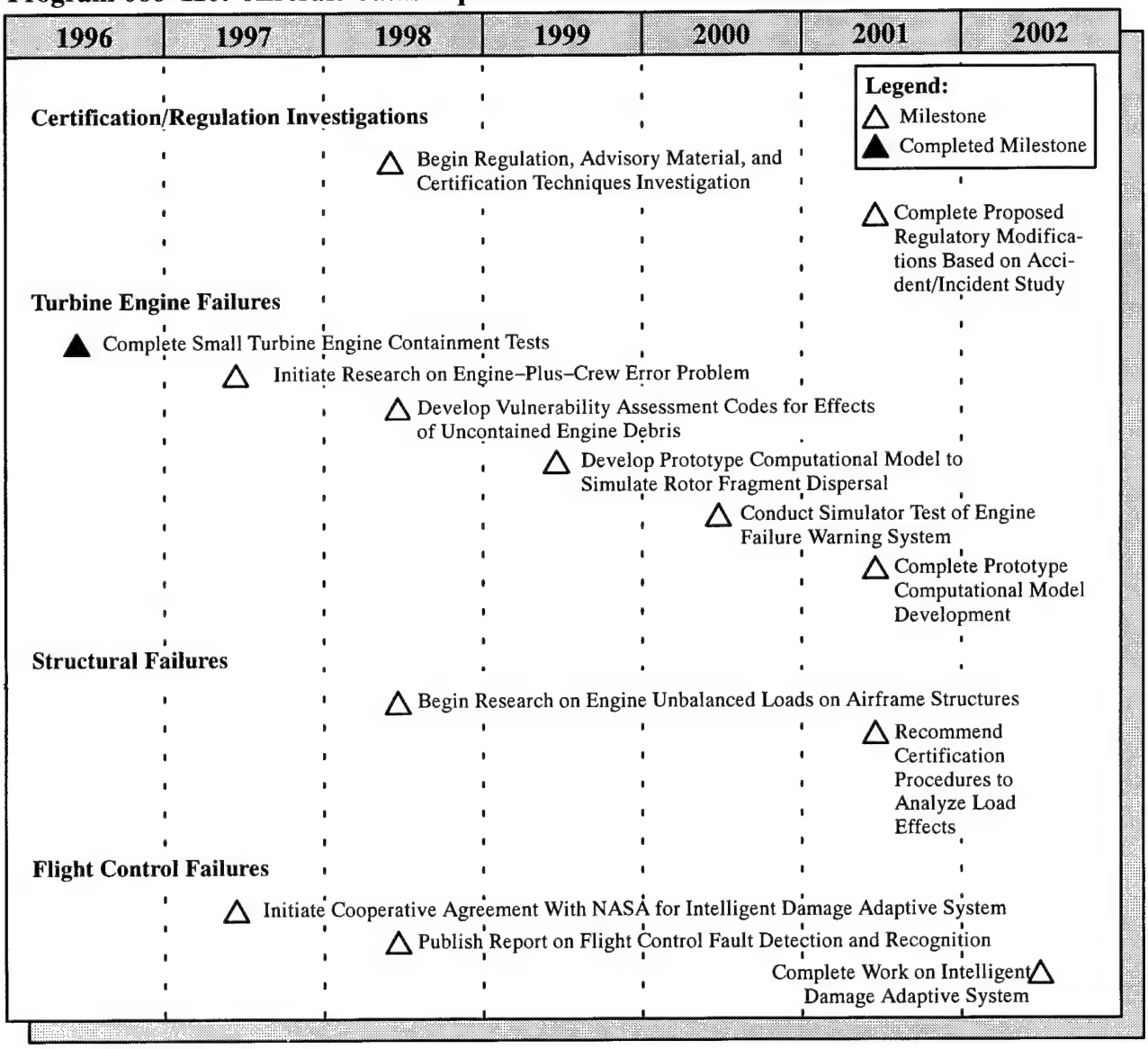
Structural Failures

Research will begin in 1998 to examine methods of modeling engine imbalance and torque seizure loads on airframe structures. This research will culminate in 2001 with the development of modeling techniques to assess the impact of these loads on the airframe, and recommended certification procedures to analyze the loads.

Flight Control Failures

In 1998, continued research will assess the viability of failed–mode flight control options for emergency operational conditions. Also in 1998, a report will be published on fault detection and recognition and fault–tolerant flight control systems. Work will continue until 2002 with NASA on the intelligent damage adaptive control system.

Program 066–110: Aircraft Catastrophic Failure Prevention Research



7.0 SYSTEM SECURITY TECHNOLOGY

The security mission area includes the range of FAA activities that minimize the chance of injury or death of people or damage or loss of property due to acts of terrorism that may be directed to the civil aviation system. The major components are aircraft, airports, airways, procedures, and human performance.

Research in the security mission area is driven by the requirement for a safe and secure aviation system. The direct benefit from an effective security system is preventing fatalities, injuries, and property losses resulting from intentional criminal acts. The indirect benefits include preventing a variety of disruptions to air traffic services and their attendant economic impact. Developing new security technologies is necessary to achieve a high security level without incurring excessive costs or inconvenience to the air transport industry or passengers.

Civil aviation continues to be an attractive target for terrorists or individuals with other criminal motives because it is highly visible. The threat level has evolved from hijacking in the mid–1970's to terrorist activities aimed at disrupting or destroying specific air transportation elements. The tragedy that befell the 270 victims of Pan Am Flight 103 over Lockerbie, Scotland, is one such act. In the United States, the immediate impact from this event was to double airline security costs from $500 million to almost $1 billion per year.

Even a threat on a specific target is sufficient to cause significant disruptions and economic impact. For example, events in the Persian Gulf during the first 3 months of 1991 reduced consumer confidence in the air transport system's security. As a result, scheduled air miles for domestic flights decreased by 5.2 percent, with international flight miles on U.S. carriers decreasing by 16.2 percent. Continued public confidence in the aviation system's security from terrorist threats, in general, and U.S. airports and carriers in particular, is key to the public using these services and the resulting economic benefits.

The Federal Aviation Administration initiatives in system security are designed to provide this confidence and achieve these benefits by developing systems that prevent or deter hijacking and sabotage. An initial mission area assessment indicates that benefits as high as $40 million per year can be achieved from reduced airport security service costs while providing increased protection. The benefit from avoiding the direct costs of just one major incident would be approximately $150 million for a wide–body aircraft plus $450 million for the lives lost.

Research in security technology is needed to counter threats that are becoming more sophisticated. The spread of terrorism makes it imperative for the FAA to identify and develop the most effective technologies that can be practically applied in security systems. Those who pose a threat to the traveling public are intelligent, committed, and innovative, striking where the system is most vulnerable. Protection must therefore be comprehensive, addressing all potential vulnerability in the airport and air traffic control facilities, as well as onboard the aircraft.

The Aviation Security Improvement Act of 1990 directs the FAA to:

- Accelerate its system security program
- Expand its system security program to address current and future threats; and
- Expand the security initiatives in the aircraft hardening and human factors areas.

The continued emphasis for research in this mission area has been on developing automated

capabilities to prevent introducing explosives onto aircraft, and enhancing human performance in the system. A broad agency announcement and solicitations for proposals have been used to identify and fund over 30 different organizations to conduct security–related research, engineering and development (R,E&D). These contracting mechanisms allow the FAA to identify and exploit innovative concepts and technologies from both industry and academia. Currently, explosive detection and pattern recognition research is underway.

The FAA's work in aviation security also involves cooperative efforts with many other government agencies such as the Departments of State, Defense, and Energy; U.S. Customs Service; Bureau of Mines; and intelligence and law enforcement agencies. International working agreements to exchange security R,E&D information are in place with Canada, the United Kingdom, France, and Israel, and others.

To support operational security systems deployment, the security R,E&D program includes tasks to devise standard test protocol and performance criteria for testing automated explosives detection systems and for giving advice on credible systems architecture for various detection techniques. Technology assessments will be performed on commercially developed security equipment utilizing the standard test protocol, and a list of approved automated explosives detection technologies will be developed for implementation by air carriers.

The results from the security R,E&D program are technologies, specifications, rules, and guidance to be used by airports and air carriers to perform their aviation security functions. The FAA does not, except for human factors and air traffic control facility protection, procure the hardware that results from the security R,E&D program.

Table 7–1, Major Security Products, provides a quick overview of major security–enhancing products from R,E&D research efforts.

Table 7–1. Major Security Products

Program Number	Program Name	Major Products
071–110	Explosives/Weapons Detection	• Airport demonstration of certified explosives detection system • Trace and bulk personnel screening portals • Certification of trace electronics screening system • Competitive computed tomography development
075–110	Aircraft Hardening	• Guidelines for blast mitigation/aircraft hardening • Engineering design specifications for aircraft and support equipment • Threat assessments on advanced terrorist weapons
073–110	Airport Security Technology Integration	• Airport vulnerability reports based on current and future threat definitions • New operations concepts and system requirements for integrated enhanced airport security responses to threats • Analytic models for threat, risk, vulnerability, and cost/benefit assessment
076–110	Aviation Security Human Factors	• SPEARS Category–X airport testing and recommendations for implementation • Human systems integration analyses and reports on new explosives and weapons detection technologies • Automated domestic profiling system

7.1 System Security Technology Program Descriptions

071–110 Explosives/Weapons Detection

Purpose: In response to the global terrorist threat to civil aviation, this program will develop improved systems and operational procedures for detecting explosives/weapons on passengers and in checked and carry–on baggage, air cargo, and mail. These improved, fully automated systems will allow rapid passenger and baggage screening to occur without interrupting passenger or baggage flow. These systems will have high detection rates with low false–alarm probabilities, thereby increasing airport and air carrier safety.

The current trend in firearm and some grenade manufacturing is toward using nonmetallic components and nonferrous alloys. These weapons may escape detection by current airport metal and weapon detection systems. This program will also develop screening systems based on alternative technologies that are capable of detecting "plastic" and other unconventional weapons on people.

Approach:

Explosives Detection

Current explosives detection systems are intrusive and labor intensive. Design goals are for systems that are fast and effective and provide a uniform, high performance level through computer assistance. The challenge is to select sensor systems appropriate to the threat and scenario, then integrate them within the constraints of an airport.

The FAA is developing two basic types of explosives detectors. The trace detection program is designed to collect, analyze, and identify trace amounts of different explosives. Since they are passive devices, trace detectors are strong candidates for screening passengers. The bulk detection program is designed to use electromagnetic energy, X–rays, or nuclear probe techniques to penetrate and identify bulk explosives based on their elemental or structural composition. In the near–term, both trace and bulk prototype detectors will be developed to provide an immediate response to today's terrorist threat. In the long–term, the emphasis will be on identification, feasibility demonstration, and subsequent development of more efficient and effective new technologies.

This program will focus on three major elements for screening checked baggage: developing prototype systems, developing combined technology prototypes, and developing new detection algorithms to upgrade existing detection systems.

Several trace portals to screen passengers are in the development stage. Emphasis is being placed on developing methods and test objects that will be used in trace certification testing. Chemiluminescence and ion mobility spectroscopy have reached the commercial stage and are leading certification candidates. The trace detector program will also key on olfaction studies that include developing improved training and testing techniques as well as evaluating canine response to various explosives.

An improved computed tomography system has recently passed FAA certification as an explosives detection system. Further development is planned to improve this system's operational characteristics. Fast neutron radiography is now being investigated and will be brought to the demonstration stage. Component research on these technologies will continue.

Weapons Detection

Methods to enhance current generation screening system performance are being investigated. Commercial weapons detection devices are being evaluated for deployment in airports, and new standards are being developed to ensure that these screening systems continue to be effective. Alternate methods to detect nonmetallic weapons and liquid explosives are also being investigated along with passenger screening systems.

Related Projects: 073–110 Airport Security Technology Integration, 075–110 Aircraft Hardening, 076–110 Aviation Security Human Factors, and 101–180 Aviation Research Grant Program. Capital Investment Plan programs: F–16 FAA William J. Hughes Technical Center Building and Plant Support and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- National Academy of Sciences Washington, D.C.
- Several national laboratories and interagency and international agreements.
- Numerous explosives and weapons detection companies.
- Grants with major universities.

Products:

- Feasibility studies
- Prototype hardware
- Project evaluation reports
- Engineering procurement specifications
- Data to support rulemaking

1996 Accomplishments:

- Tested the multi–view dual energy X–ray system.
- Completed installation of certified explosives detection systems at three major airports.
- Completed evaluation of several commercial trace systems.
- Conducted airport test of trace passenger portal.
- Developed canine readiness field test.
- Completed trace electronics protocol.
- Conducted laboratory demonstration of a dielectric and millimeter wave explosives/ nonmetallic weapons detection portal.
- Conducted airport data collection on dielectric and nuclear magnetic resonance bottle screening systems.
- Completed laboratory and airport tests of quadrupole resonance baggage inspection system.
- Supported Atlanta Olympics games security by deploying explosives detection equipment at designated airports.
- Completed passenger screening protocol using commercial trace systems in the contact mode.
- Certified the advanced computed tomography explosives detection system, CTX 5000SP.

1997 Projected Accomplishments:

- Complete airport demonstration of certified explosive detection systems.

- Complete laboratory prototype trace cargo screener.
- Complete feasibility study for bulk cargo screening systems, and conduct laboratory tests on cargo containers.
- Complete development of computer automated design–based luggage simulation software and luggage contents database.
- Conduct performance tests of bottle screening systems.
- Conduct airport tests of trace document screener and alternative portal concept.
- Complete feasibility studies for combined bulk/trace and quadrupole resonance/X–ray baggage inspection systems.
- Certify trace detection systems for electronics screening.
- Develop International Civil Aviation Organization (ICAO) explosive marker generators.
- Complete dielectric and millimeter wave explosives/nonmetallic weapons detection portal.
- Complete pulsed fast neutron analysis test.

Planned Activities:

Explosives Detection

First-generation bulk detection systems will continue to be deployed while new detection systems development, including prototype trace portals, will continue with operational testing scheduled from 1998 through 2002.

In 1998, nuclear research will focus on cargo screening feasibility studies. Testing will be performed on laboratory prototype systems for fast neutron spectroscopy/radiography and alternate multi-sensor systems designed for integration with compatible systems. Also in 1998, a baggage screening system simulation will be completed. Enhanced X–ray systems integration with trace and/or other technologies will be initiated and studied. Additional trace portal prototypes will be completed, and testing will begin at airports in the United States. Trace detection systems will be upgraded for new threats, and an automated trace baggage system will be built. A cargo container nuclear/X–ray scanning system laboratory prototype will be tested in 1998 for explosives detection jointly with another agency.

In 1998, competitive computed tomography development will be completed. A biotechnology trace detector prototype for area screening will be tested. Also, an automatic multi–technology passenger scanning portal will be developed to combine explosives and weapons detection systems. Additionally, an operational test of a nerve gas mitigation system will be conducted onboard an aircraft. All commercial trace detection systems will be upgraded to detect ICAO markers. Also in 1998, an airport test of a trace cargo screening system will be conducted. In 1999, development of a combined technology inspection system will be completed. Also in 1999, a substance–specific detection system will be developed that can satisfy the explosives detection device criteria.

In 2000, a prototype standoff trace detection system will be developed to detect large explosive devices. Also in 2000, candidate cargo inspection technologies will be evaluated for further development. An integrated trace, bulk, and new threat detection system for baggage inspection will be developed in 2002 to replace multiple detection systems in airports.

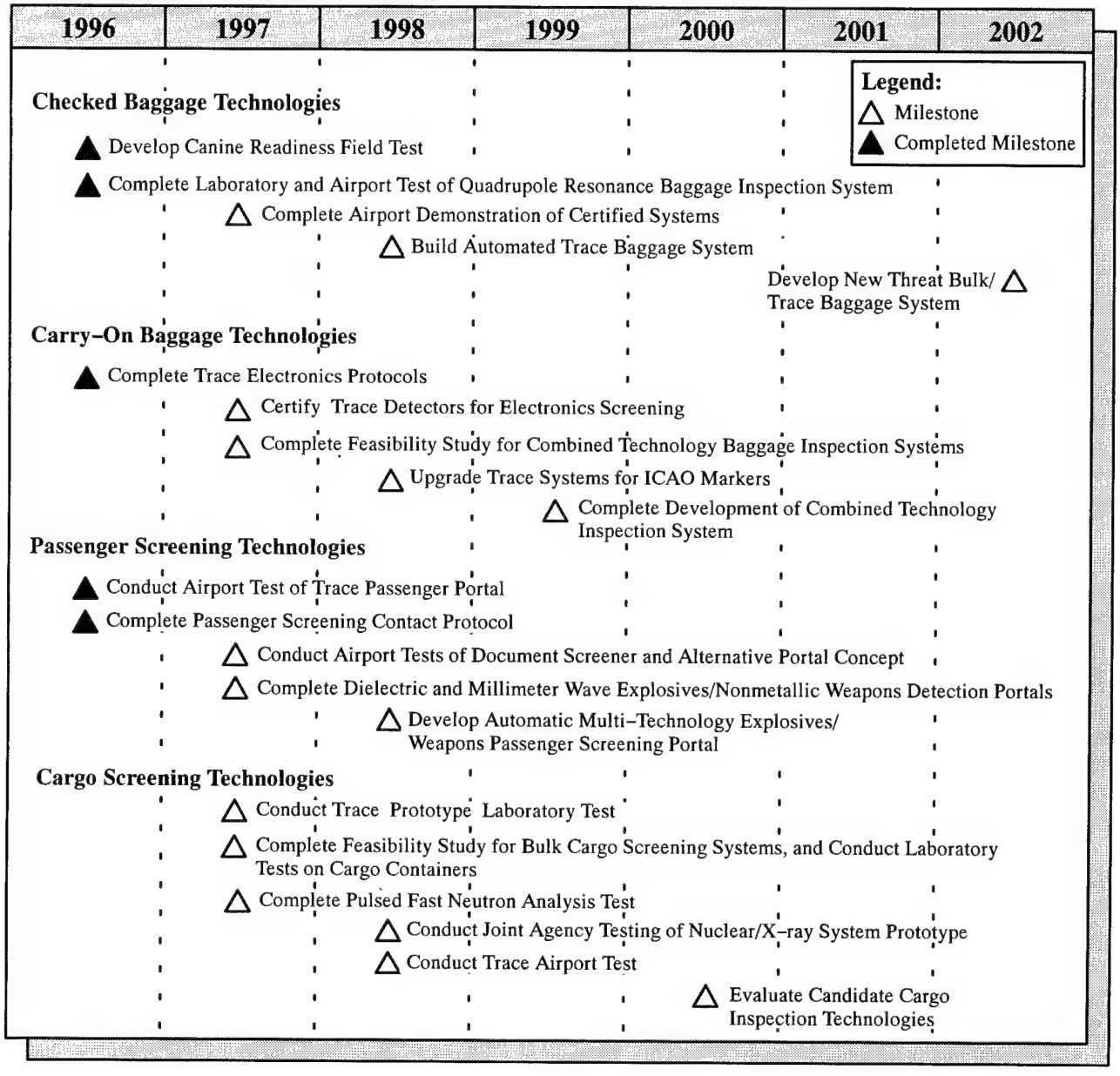
Weapons Detection

In 1998, bottle screening certification standards will be published. In 1999, an automatic multi–technology passenger scanning portal will be developed to combine weapons detection systems with trace explosives detection techniques. The portal will then be tested in the laboratory.

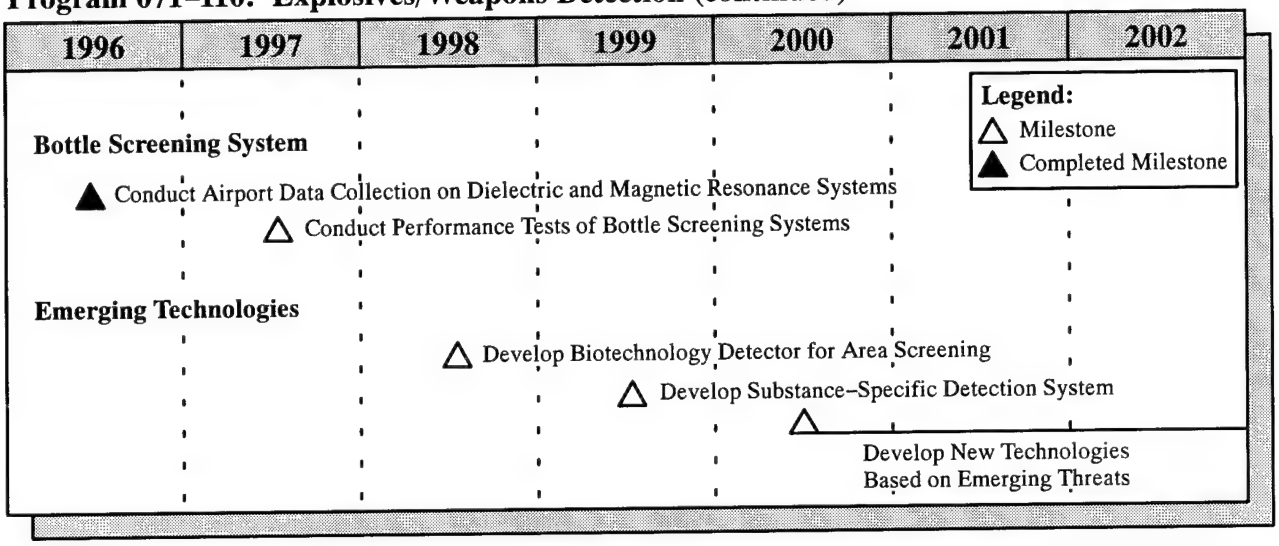
Emerging Technologies

New technologies will be identified and developed based on emerging threats, and those showing promise will be operationally tested in the laboratory and airports. Broad agency announcements, the grants program, or similar vehicles will continue to identify innovative approaches to this challenging problem, and synergistic combinations of the sensor systems identified will be examined.

Program 071–110: Explosives/Weapons Detection



Program 071–110: Explosives/Weapons Detection (continued)



073–110 Airport Security Technology Integration

Purpose: Providing enhanced security in an airport environment for multiple threats in a cost–efficient manner is a national priority. This program will determine the operational effectiveness, impact, and cost for enhanced airport security by using demonstration airports. Establishing demonstration airports will provide real–time testbeds for evaluating new security technology and procedures integrated into the operational environment.

This program also will evaluate airport security from a systems approach, determine if current systems integration is adequate, identify alternatives to counter evolving security threats, and identify additional requirements for research and development. A cost–effective and unobtrusive security system will become an integral part of normal civil aviation operations resulting from the various security research efforts that are currently underway.

Approach: Technology and procedures system integration and operational testing will determine whether new technologies and procedures are ready to be implemented in the operational aviation system, or whether further development is needed. New or enhanced training and operational procedures will be validated. Additionally, operational test results will be evaluated against threat/risk assessment and requirements definition to determine if the R,E&D products meet the objectives.

Protection for airport targets has been prioritized based on current and predicted future terrorist threats. The prioritized targets have been correlated with existing FAA regulations and actual airport security plans. Enhanced system design and operational procedures will be developed to counter higher threat levels while maintaining economic viability, responsiveness, and normal passenger flow. New security designs and operational procedures will be implemented and evaluated in a testbed environment at domestic and international airports as needed. These testbeds will be used to test new technology in an operational environment for performance characteristics and operational procedures through cooperative research and

development agreements with the aviation industry. Successful equipment will be considered for use throughout the system as appropriate.

This program will interpret and translate threat information into functional security system requirements using accepted analytical methods and tools. Modeling and applied research necessary to define security system parameters and constraints will be conducted. The model will contain information on current and future threats as well as technologies to counter each threat.

A long–range, strategic plan for developing and deploying aviation security system components will be developed to ensure that all components, attributes, and relationships needed to achieve a higher security level are identified and integrated into the system.

Alternative security system design approaches will be evaluated through system cost–effectiveness analyses and tradeoff studies. A feedback mechanism will be established for updating system requirements on a continuing basis as new threat or technology issues are identified through intelligence activities, research developments, and/or operational equipment and procedures testing.

Related Projects: 051–110 Airport Planning and Design Technology, 071–110 Explosives/ Weapons Detection, 076–110 Aviation Security Human Factors, and 101–180 Aviation Research Grant Program. Capital Investment Plan programs; F–16 FAA William J. Hughes Technical Center Building and Plant Support, and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Abacus Technologies, Inc.
  Chevy Chase, Maryland
- Digital Control Systems, Inc.
  Yardley, Pennsylvania
- Crown Communications, Inc.
  Washington, D.C.

Products:

- Airport vulnerability reports based on current and future threat definitions
- Integrated airport security conceptual design
- Upgraded airport security testbeds
- Test and evaluation reports
- Operational procedures, guidelines, training curricula, and effectiveness measures
- New operations concepts and system requirements for integrated enhanced airport security responses to threats
- Analytic models for threat, risk, vulnerability, and cost/benefit assessment
- Long–range strategic plan for research, design, development, and deployment of enhanced integrated airport/aviation security systems

1996 Accomplishments:

- Developed security technology standards for access control with RTCA.
- Hosted annual task force planning group to identify technologies for countering aviation industry threats, and published classified report.
- Developed analytical models for threat/risk/ vulnerability assessment.

- Conducted study and published report of positive passenger baggage matching for domestic implementation.

- Developed threat/technology/countermeasures data base.

1997 Projected Accomplishments:

- Transfer radio frequency technology for baggage and passenger tracking to industry.

- Develop passenger/baggage flow model.

- Validate vulnerability assessment tool utilizing selected airport security data.

- Integrate explosive detection systems and other security vulnerability countermeasures into an operational testbed to validate security benefits and operational impact.

- Transfer vulnerability assessment tool technology to industry.

- Conduct blast model analysis.

- Publish functional requirements for an airport vulnerability analysis tool, and validate selected commercial–off–the–shelf vulnerability assessment tool against these requirements.

- Publish annual classified threat assessment report.

- Develop standards for revolving doors to reduce the need for security personnel at concourse exit.

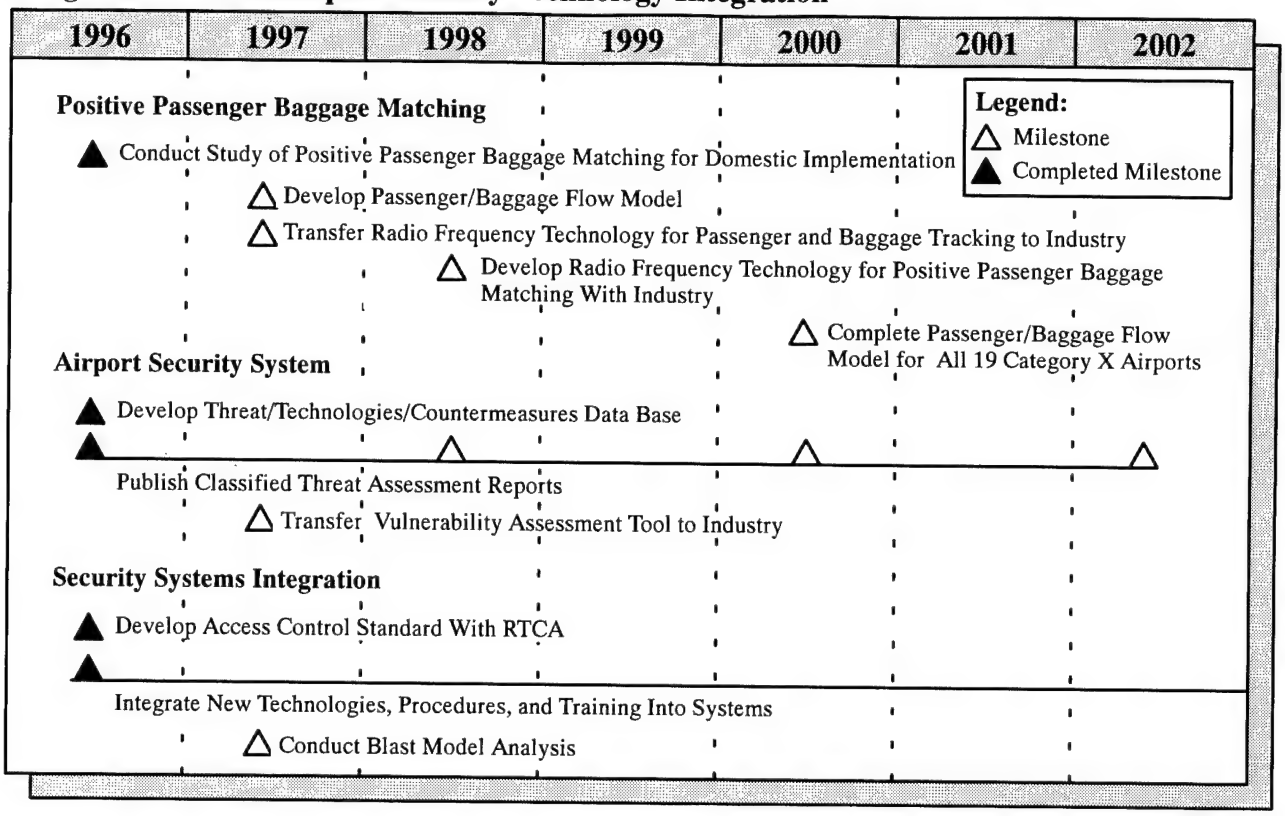
Planned Activities: An analysis process will be used to evaluate countermeasures and initiate requirements for research and development as new advanced threats emerge. Opportunities for new testbed installations will be investigated at various airports, taking advantage of existing or ongoing construction programs.

Threat/risk model work with other government agencies will continue in 1998, and interfaces with other government agency systems will be expanded. Sensor integration analytic evaluations will also be performed as new technologies emerge.

In 1998, a classified report on countermeasures for new advanced technical means of attack will be published, and an airport security vulnerability assessment tool will be completed.

In 1998, work will continue with industry to develop radio frequency technology for positive passenger baggage matching. By 2000, a passenger and baggage flow model will be used to simulate the effects of security enhancements at 19 high–volume, high–risk, domestic airports servicing international flights (Category X). Work will continue beyond 2002 for security integration and training. Analytic evaluations will be performed as new technologies emerge.

Program 073–110: Airport Security Technology Integration



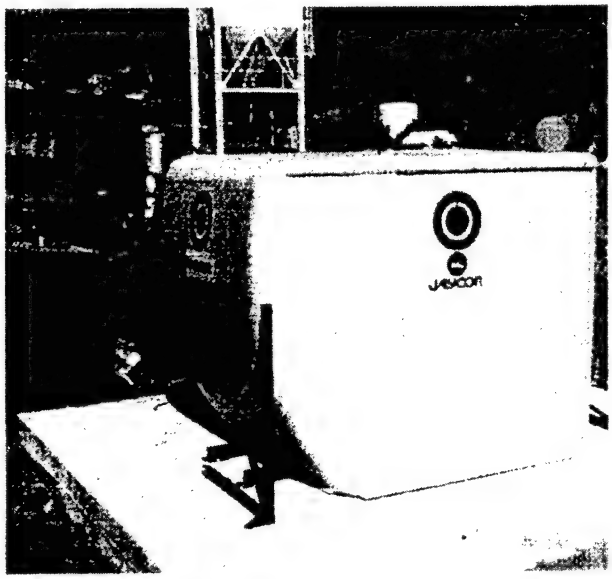
075–110 Aircraft Hardening

Purpose: The threat to commercial aircraft and passenger survival due to the in–flight detonation of a small explosive device is significant. This program will identify methods to increase aircraft survivability by reducing damage effects caused by a small explosive detonation on a commercial airliner. Balancing current technology detection capability and aircraft hardening to withstand damage from a detonation in flight will be accelerated, as required by the Aviation Security Improvement Act of 1990. In addition, the program is assessing possible terrorist threats to civil aviation caused by projected energy, man–portable surface-to-air missiles, and specifically directed electromagnetic sources.

Approach: Blast loading parameters caused by various explosive types and quantities will be determined. Models will be developed to predict damage to an aircraft resulting from explosive detonations. Explosives testing will be conducted on aircraft and/or other test devices to verify models and assess damages using various scenarios. These tests will also be used to help determine aircraft vulnerability and validate blast mitigation/structural hardening techniques. Additionally, testing will be used to evaluate least–risk guidelines. Once failure mechanisms are identified, methods to protect an aircraft against catastrophic structural failure due to an in–flight explosion will be developed. To assess the civil threat from projected energy beams,

electromagnetic sources, and surface-to-air missiles, this program will use the extensive capabilities of the Department of Defense and other agencies.

Related Projects: 064–110 Flight Safety/Atmospheric Hazards, 065–110 Aging Aircraft, 066–110 Aircraft Catastrophic Failure Prevention Research, 071–110 Explosives/Weapons Detection, and 101–180 Aviation Research Grant Program. Capital Investment Plan programs: F–16 FAA William J. Hughes Technical Center Building and Plant Support and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.



Blast Resistant Container

University/Contractor Support:

- Pennsylvania State University
  State College, Pennsylvania
- Interagency Agreement s– Wright Laboratories, Naval Research Laboratory, and Phillips Laboratory

Products:

- Project evaluation reports
- Prototype hardware
- Guidelines for blast mitigation/aircraft hardening
- Engineering design specifications for aircraft and support equipment
- Threat assessments on advanced terrorist weapons

1996 Accomplishments:

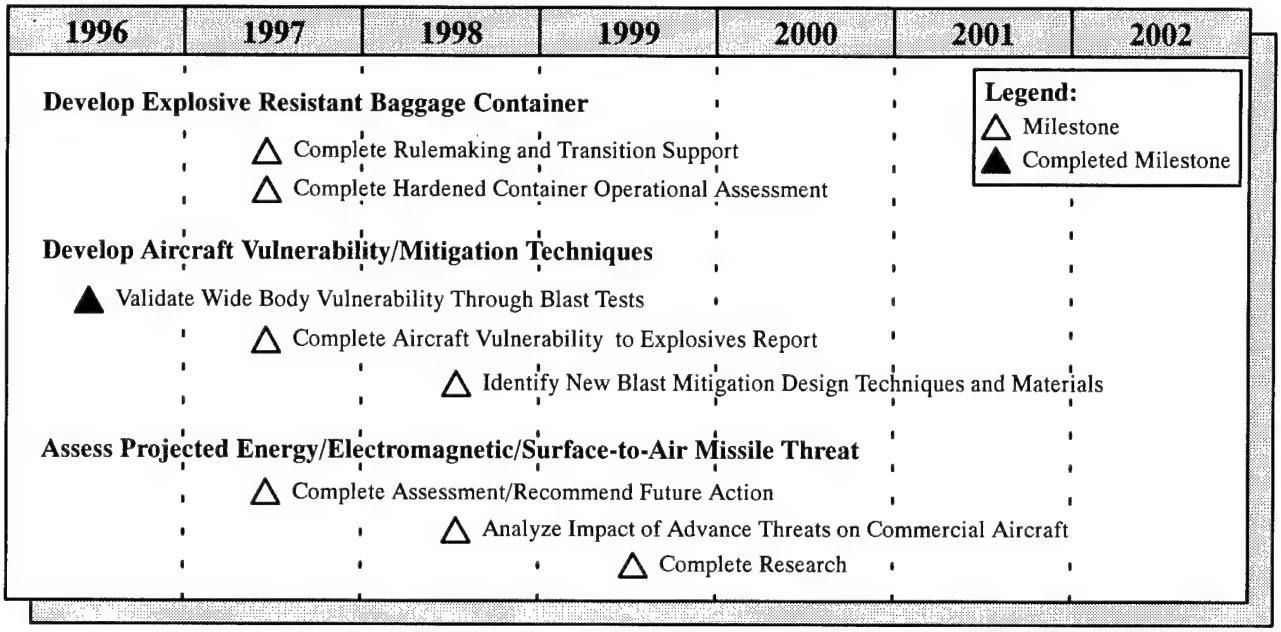
- Provided support for hardened container rulemaking activities to include operational in–use assessments.
- Validated wide body vulnerability through actual aircraft blast tests.
- Identified and validated mitigation techniques for projected energy, electromagnetic, and surface–to–air missile threats.
- Transitioned all container–related research data to the private sector.
- Analyzed data from ongoing prototype hardened container demonstrations.

1997 Projected Accomplishments:

- Complete hardened container operational assessment and rulemaking assistance.
- Complete aircraft vulnerability to explosives report.
- Provide Congressional report on cost/trade–offs of aircraft hardening versus detection for explosive threat.
- Analyze results of advanced threats vulnerability studies, providing recommended actions for alleviation.

Planned Activities: In 1998, as the vulnerability assessments evolve, ideas to mitigate blast either through retrofitting the current fleet or instituting new design techniques and materials will be identified. These ideas and concepts will be analyzed and tested, and recommendations for new specifications will be made as required. In addition, analyses of the impact of electromagnetic, projected energy, and man portable air defense systems on commercial aircraft will continue with completion by the end of 1999.

Program 075–110: Aircraft Hardening



076–110 Aviation Security Human Factors

Purpose: This program carries out the mandate of the Aviation Security Improvement Act of 1990, Public Law 101–604. This law's intent is to "maximize human performance" within the aviation security system and "include research and development of both technological improvements and ways to enhance human performance."

Approach: This program addresses three primary areas: human systems integration for new equipment designs; security system and operational procedures development and testing; and security personnel selection, training, and performance monitoring. A key element is leveraging research and collaborating with other government agencies, the aviation industry, and academia.

The screener enhancement project will will focus on an airport demonstration of the screener proficiency evaluation and reporting system (SPEARS) technology for enhancing operator acquisition and sustainment training as well as performance monitoring. SPEARS has completed operational test and evaluation to determine deficiencies and identify additional research requirements. The airport demonstration will be follow–on operational tests and

evaluations conducted to confirm full functional capability.

An airport demonstration will also be conducted with computed tomography scan technology. This demonstration will evaluate systems for associated acquisition and sustainment training as well as performance monitoring.

The passenger profiling project will expand an automated domestic passenger profiling capability that analyzes a set of parameters determined by an interagency panel of security experts. This system will identify passengers not requiring additional security screening. Implementation strategies will be determined for both active and passive profiling techniques. Also, this project will evaluate how acceptable increased security measures are to the flying public relative to costs and delays.

Human systems integration will address the equipment characteristics required for operators to interface with security screening equipment resulting from emerging technologies. This project focuses on conducting assessments, developing procedures, and testing detection technologies for the various security areas within an airport environment. An important element of this research will be evaluating the complexity of multiple positions at a futuristic screening checkpoint for passengers and carry–on baggage.

Related Projects: 071–110 Explosives/Weapons Detection, 073–110 Airport Security Technology Integration, and 101–180 Aviation Research and Grant Program. Capital Investment Plan programs: F–16 FAA William J. Hughes Technical Center Building and Plant Support, and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- NYMA
  Washington, D.C.
- InVision
  Foster City, California
- Public Computer Systems, Inc.
  Rochester, New York
- EG&G Astrophysics
  Long Beach, California
- Airline grants to 13 United States air carriers

Products:

- SPEARS Category–X airport testing and recommendations for implementation
- CTX 5000 computed tomography scan airport testing and recommendations for implementation
- Human systems integration analyses and reports on new explosives and weapons detection technologies
- Automated domestic profiling system
- Recommendations, guidelines, and regulatory packages for security training

1996 Accomplishments:

- Expanded automated domestic profiling system.
- Developed active and passive profiling techniques and determined their domestic implementation considerations.
- Completed development of SPEARS components.

1997 Projected Accomplishments:

- Publish report on emerging detection technologies.

- Develop international automated profiling system.
- Develop, operationally test, and evaluate an automated domestic passenger profiling system with Northwest Airlines.
- Apply SPEARS (screener selection, training, and testing) to the emerging technologies.
- Complete development of Category–X airport demonstration operational test and evaluation of SPEARS candidates.
- Complete computed tomography scan airport demonstration operational test and evaluation.

Planned Activities:

Human Systems Integration

From 1998 through the end of the program, emerging technologies will be evaluated annually. As new technologies emerge they will be periodically evaluated as countermeasures.

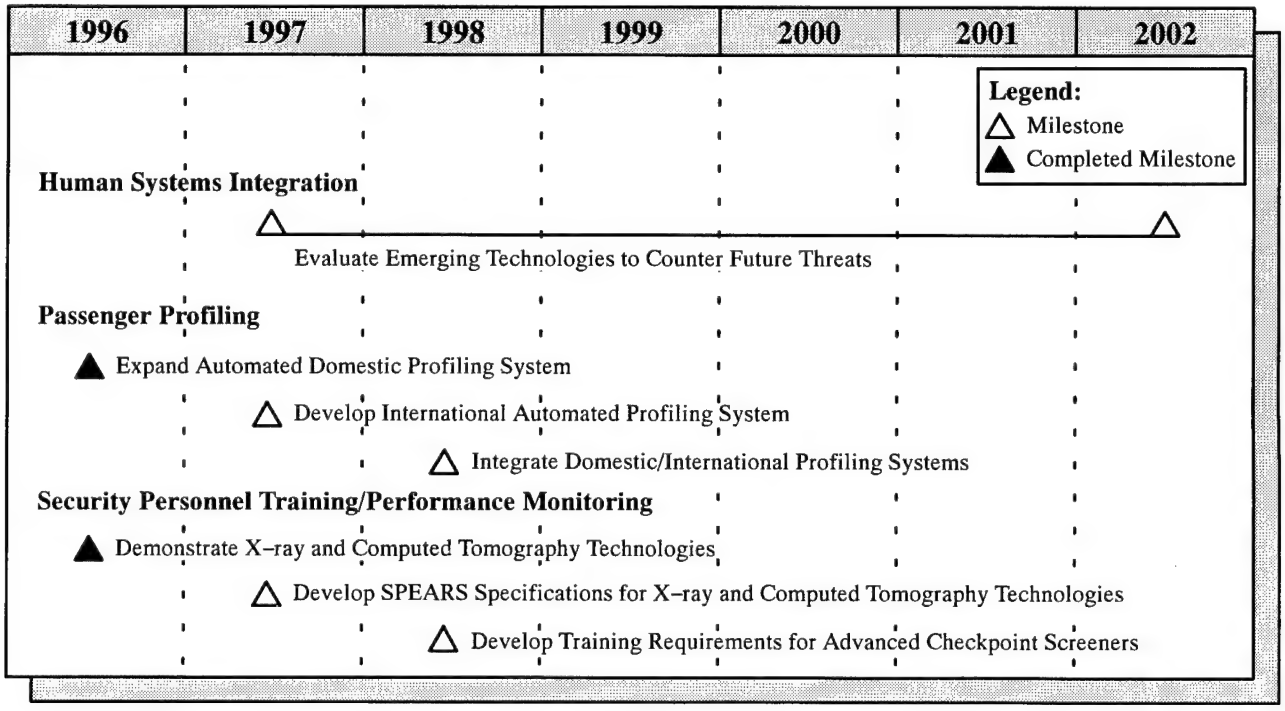
Passenger Profiling

In 1998, domestic and international profiling systems will be integrated. As new requirements emerge, they will be periodically evaluated.

Security Personnel Training/Performance Monitoring

Training requirements for advanced checkpoint screeners will be developed in 1998. As new system and personnel security threats emerge, technologies will be periodically developed and evaluated to counter these threats.

Program 076–110: Aviation Security Human Factors



8.0 HUMAN FACTORS AND AVIATION MEDICINE

The human operator's role across all components of the National Airspace System (NAS) is critical to safe and efficient system operations. Advances in technology have increased the reliability of most system components, but the percentage of human error–related incidents and accidents has remained fairly constant. Historically, flight crew error has been cited as a contributing cause in over 60 percent of jet transport accidents, and the impact of human error is even higher when air traffic controllers, dispatchers, maintenance workers, and others are factored in.

Public, industry, and government concern for the human element in system performance resulted in Congress enacting the Aviation Safety Act of 1988 (Public Law 100–591), that called for the FAA to augment its research efforts in human factors and to coordinate programs with the National Aeronautics and Space Administration (NASA). The National Plan for Civil Aviation Human Factors: An Initiative for Research and Application published in 1995, hereafter referred to as The National Plan For Civil Aviation Human Factors, represents the most current effort to strategically address human factors research requirements.

The human factors programs in the safety mission area directly support the National Plan for Civil Aviation Human Factors and the validated needs of internal and external users. These programs address major human factors priority areas related to: flight deck, air traffic control (ATC), flight deck/air traffic control system integration, airway facilities, aircraft maintenance, and aeromedical aircraft cabin environments.

Human factors research programs generally produce information as opposed to hardware. This information will continue to influence systems design, certification and regulation decisions, operations directives, and training procedures. The ultimate result is a safer and more efficient NAS Operation.

Human–Centered Automation

Human–centered automation research focuses on the role of the operator and the cognitive and behavioral effects of using automation to assist humans in accomplishing their assigned tasks for increased safety and efficiency. The research in this area addresses the identification and application of knowledge concerning the relative strengths and limitations of humans in an automated environment. It investigates the implications of computer–based technology to the design, evaluation, and certification of controls, displays, and advanced systems.

Selection and Training

Research in this area strives to understand the relationship between human abilities and aviation task performance; to enhance the measures and methods for the prediction of future job/task performance; to develop a scientific basis for the design of training programs, devices, and aids; to define criteria for assessing future training requirements; and to identify new ways to select aviation system personnel.

Human Performance Assessment

The major objectives of the research in this area are to identify the intrinsic characteristics of individual and teams that determine how well they are able to perform aviation tasks; to characterize the impact of environmental and individual factors on human performance; and to improve and standardize methods for measuring human performance.

Information Management and Display

Research in this area addresses the presentation and transfer of information among components in the NAS. It seeks to identify the most efficient and reliable ways to display and exchange information; to determine what, when, and how one might best display and transfer information to system components; to design the system to reduce the frequency of information transfer errors and misinterpretations; and to minimize the impact when such errors do occur.

Bioaeronautics

Bioaeronautics involves the bioengineering, biomedicine, and biochemistry associated with performance and safety. The objective is the enhancement of personal performance and safety by maximizing crew and passenger health and physiological integrity.

Table 8–1, Major Human Factors and Aviation Medicine Products, provides a quick overview of major human factors–enhancing products from R,E&D research efforts.

Table 8–1. Major Human Factors and Aviation Medicine Products

Program Number	Program Name	Major Products
081–110	Flight Deck, Aircraft Maintenance, Flight Deck/ATC, System Integration Human Factors	• Refined model advanced qualification program (AQP) for FAR Part 135 and Part 121 operators, and flight training centers, to include ab initio and recurrent crew training and assessment requirements • Human factors guidelines to reduce automation–related errors in maintenance for government and industry • Human factors guidelines for developing, testing, and certifying interface designs of various computer/human interface applications • Capability to assess human performance in a highly integrated future automation environment such as free flight
082–110	Air Traffic Services Human Factors	• Qualitative and quantitative human factors reference information to assist in designing, integrating, and evaluating Air Traffic and Airway Facilities systems that enhance task performance, reduce workload, and promote productivity • Tools and reference information for improved selection and training programs • Analyses that characterize miscommunications in the ATC system and offer recommendations for corrective action
086–110	Aeromedical Research	• Quantitative bioengineering criteria to support evacuation capabilities, flotation devices, and other onboard rescue equipment certification • Quantitative biomedical criteria to support protective breathing equipment and operational procedures certification • Quantitative biochemical and toxicological criteria supporting the use or certification of aircraft interior fire, smoke, and toxicity limits

8.1 Human Factors and Aviation Medicine Program Descriptions

081–110 Flight Deck, Aircraft Maintenance, Flight Deck/ATC System Integration Human Factors

Purpose: Statistics show that approximately 65 percent of all fatal civil air transport accidents and a higher proportion of general aviation accidents list human error as a probable cause. Since human errors contribute to the majority of aircraft accidents, a continuing program directed toward improved flight deck human engineering, identification and mitigation of work environment factors affecting flightcrew, maintenance, and inspection personnel performance, and enhanced individual and team training can pay for itself many times over by preventing a single accident. Additionally, properly human factored new technology developments, and better pilot, maintainer, and inspector performance using existing technology, will provide further benefits by increasing operational efficiency.

This program will improve pilot, aircraft maintenance, and inspection personnel performance and reduce the adverse effects of flightcrew, maintenance, and inspection errors through improved systems design, procedures, and training. An important element in this research is, when possible, applying existing knowledge of human capabilities and limitations to the flight deck and maintenance environments. Where existing knowledge is inadequate, this program will develop a better understanding of human performance factors.

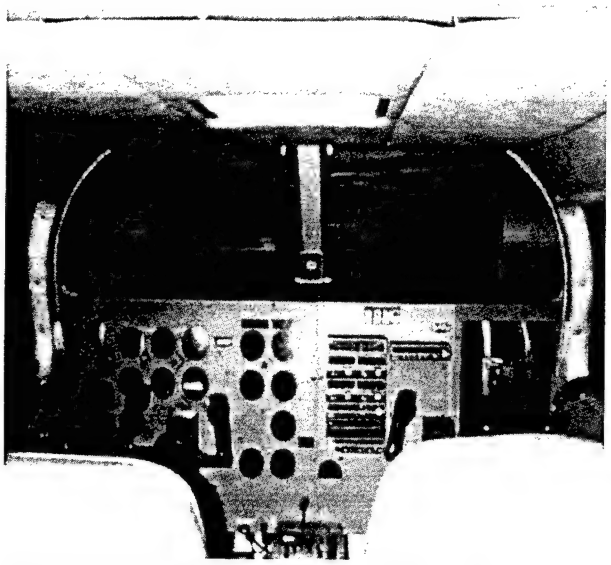
This program will also ensure new generation aircraft compatibility with the evolving automated NAS and decrease the frequency of flight deck/ATC communications errors through a total system approach. Flight deck/ATC integration raises unique considerations that are distinct from either ATC or flight deck issues and will be greatly affected by the technological improvements that are expected to occur simultaneously within both areas. Advanced computer aiding will facilitate controllers handling increased traffic but will also influence flightcrew performance and situational awareness. Data link, and ultimately satellite–based air traffic systems, have the potential to enhance system capacity, but will also influence controller and pilot workload in ways that are not currently understood. The transition to a free flight concept of operations accelerates the need to effectively address these issues. NAS safety and efficiency will be enhanced through system–wide analyses that integrate current and emerging airborne and ground subsystems.

Approach: An important focus for the program is responding to relatively short–term requirements from sponsor organizations. A long–range goal is to develop the corporate human performance knowledge base that will scientifically support future rulemaking and safety programs. Analytical, laboratory, simulation, and field operational studies will be conducted in the following National Plan for Civil Aviation Human Factors areas: human–centered automation, human performance assessment, selection and training, and information management and display. Information in data bases will be used to analyze the effects of selected human factors improvement methods, training, individual and operational stressors, and implementing increased automation.

Organizational/managerial research will examine the influence of management practices, expectations, and norms as well as personnel practices, team operations, and organizational structure on flight deck and maintenance performance. Research reports, conferences, and direct assistance to operational organizations will be

used to support operational evaluations and develop advisory circulars, technical standard orders, and Federal Aviation Regulations (FAR) changes. Participation in technical committees such as the Society of Automotive Engineers will assist with developing industry practices and standards.

An additional program focus is to enhance flight deck/ATC information transfer and management; decrease frequencies and consequences of flight deck/ATC errors; determine appropriate authority allocation between flight deck and ATC; and develop the required methods, tools, and guidelines for integrating NAS components into the current and future flight deck/ATC environment. The goal is to reduce information transfer errors and minimize their impact when they occur.



Aircraft simulators are valuable tools for addressing the many facets of individual and crew performance in the flight deck environment.

Related Projects: 022–140 General Aviation and Vertical Flight Program, 025–110 National Simulation Capability (NSC), 031–110 Aeronautical Data Link Communications and Applications, 082–110 Air Traffic Services Human Factors, and 086–110 Aeromedical Research. Capital Investment Plan programs: A–20 Integrated Flight Quality Assurance, M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance, and M–24 National Aviation Safety Data Analysis Center (NASDAC).

University/Contractor Support:

- Case Western Reserve University
  Cleveland, Ohio
- Clemson University
  Clemson, South Carolina
- Embry–Riddle Aeronautical University
  Daytona Beach, Florida
- Ohio University
  Athens, Ohio
- Ohio State University
  Columbus, Ohio
- Oklahoma State University
  Stillwater, Oklahoma
- University of Minnesota
  Minneapolis/St. Paul, Minnesota
- Texas Tech University
  Lubbock, Texas
- University of Illinois
  Urbana–Champagne, Illinois
- Massachusetts Institute of Technology
  Cambridge, Massachusetts
- Oregon State University
  Corvallis, Oregon
- Washington University
  St. Louis, Missouri
- State University of New York at Buffalo
  Buffalo, New York

- Volpe National Transportation Systems Center
  Cambridge, Massachusetts

- JIL Systems
  Washington, D.C.

- Galaxy Scientific
  Atlanta, Georgia

- Science Applications International Corporation
  McLean, Virginia

- Walter Reed Army Medical Center
  Washington, D.C.

Products:

- Guidelines for the human factors design, evaluation, and certification of advanced technology flight deck displays and control systems

- Research data base integrating information on pilot medical history, age, prior experience, airmanship history, and information on accidents and incidents

- Pilot and flightcrew behavioral coding techniques that can be used to assess flightcrew training program effectiveness

- Guidelines for improved training programs in crew resource management, including aeronautical decisionmaking, team situational awareness, and leadership/followership strategies

- Guidelines for selecting and training pilot instructors/evaluators

- Guidelines for line–oriented flight training scenario development and assessment

- Training guidelines for appropriate monitoring behaviors for pilot not flying

- Guidelines for qualifying flight training devices and simulators for training/airman certification

- Refined model advanced qualification program (AQP) for FAR Part 135 and Part 121 operators, and flight training centers, to include ab initio and recurrent crew training and assessment requirements

- Specification of integrated navigation displays and memory aids that provide cost–effective options to general aviation pilots for reducing risk exposure and enhancing pilot performance

- Human factors guidelines to establish policies for data link architectures and procedures

- Human factors guidelines for developing, testing, and certifying interface designs of various computer/human interface applications

- Operational and training recommendations to reduce pilot/controller verbal and digital communication errors

- Capability to assess human performance in a highly integrated future automation environment such as free flight

- Job task and training analyses for aircraft maintenance technicians

- Human factors and ergonomics audit program in maintenance shops

- Human factors guidelines to reduce automation–related errors in maintenance for government and industry

- Intelligent tutoring systems in aircraft maintenance environment

- Advanced documentation technology to provide rapid access to aircraft maintenance technical information

1996 Accomplishments:

- Completed beta test for prototype automated performance measurement system (APMS) with two U.S. air carriers.

- Developed model AQP for training centers to support regional air carrier involvement.

- Developed guidelines for effective crew performance debriefing in line–oriented flight training.

- Identified flight crew leadership/followership skills for training course development.

- Developed a video, computer based training, and printed training modules for the general aviation personal minimums checklist.

- Developed training scenarios for use in the small aircraft flight environment training system.

- Developed a computer based training module for decision training of pilots of mid–altitude, high performance aircraft.

- Provided educational outreach to the aviation community through the NASA/FAA fatigue countermeasures training module.

- Developed the fatigue crew resource management education module.

- Prototyped the first computer model of fatigue impact on work scheduling.

- Completed research linking visual strategies correlated to fatigue.

- Specified minimum requirements for electronic chart formats for use in terminal area procedures.

- Evaluated the effectiveness of alternative course–deviation–indicator display formats for minimizing flight technical errors in terminal operations.

- Completed National Transportation Safety Board data base analysis of controlled flight into terrain accidents for ground collision avoidance system alerting displays.

- Developed pilot performance data through flight simulation for use in establishing certification standards for autonavigation and control systems.

- Identified flight crew procedural recommendations for loss of clearance information in the data link environment.

- Completed assessment of data link timing and procedural constraints in different airspace types (en route and terminal).

- Identified relevant research findings in the field of data link human factors that will correspond to human factors issues in the free flight domain.

- Developed concept guidelines on maintenance technician resource management.

- Supported Sandia Laboratories visual inspection using previously developed visual inspection and non–destructive inspection guidelines.

- Developed and evaluated work environment influence on aircraft maintenance technician performance.

- Implemented and evaluated human factors and ergonomics program in aircraft maintenance shops.

- Evaluated situational awareness training needs related to aircraft maintenance environment.

- Updated Aircraft Maintenance Human Factors Guide.

- Developed electronic version of Aircraft Maintenance Human Factors Issues Guidebook.

1997 Projected Accomplishments:

- Complete evaluation of general aviation head–up display design.

- Identify control/display requirements for general aviation aircraft in a free flight environment with emphasis on separation assurance.

- Develop a weather–related decision training module for general aviation pilots.

- Validate general aviation training modules for personal minimums and mid–altitude decisionmaking.

- Complete evaluation of terrain alert and escape instruction formats for ground collision avoidance system displays.

- Refine and field test the human fatigue model.

- Exercise the first fatigue risk/exposure diagnostic tools in operational environments.

- Evaluate data link communications for air–to–air and air–to–ground communications related to transgression of free flight zones.

- Assess the impact of data link versus voice on the size and timing of free flight alert zones.

- Refine model AQP for FAR Part 135 and Part 121 operators.

- Complete research and develop draft AC120–54 revision on AQP for the approval process.

- Develop methods to analyze AQP crew performance data.

- Develop preliminary guidelines for aviation team training focusing on crew decisionmaking, situational awareness, and leadership/followership processes.

- Complete development of the aero model, motion, and visual criteria for validating level B simulator.

- Complete research and develop a draft advisory circular on aircrew training for automated flight deck environments.

- Update aircraft maintenance human factors issues guidebook.

- Implement and evaluate maintenance research management prototype training in air carrier operations.

- Develop a prototype expert system for integrated training, job aiding, and information retrieval in the aircraft maintenance environment.

Planned Activities:

<u>Human–Centered Automation</u>

In 1998, an expert system will be completed for integrated training/job aiding/information retrieval in the aviation maintenance environment.

From 1998–2001 research will continue to identify and mitigate flight deck automation related crew performance impacts.

Selection and Training

In 1998, AQP research will continue refining the model AQP for Part 121 and 135 operators with completion expected in 2000.

Also in 1998, efforts will continue to refine the preliminary aviation team training guidelines and produce the final guidelines. This research will also examine the decisionmaking process among dispatchers, air traffic controllers, and pilots. Research will continue through 1999 and will address free flight implications for distributed decisionmaking.

From 1998 through 2000, systematic research efforts will quantify the performance transfer for level 1–7 flight training devices, and level A–D certification/training recommendations will be completed. This research is needed to establish the allowable credit for training and checking tasks when using a flight training device in place of actual aircraft flight training and testing. This effort specifically addresses critical needs of commuter airlines.

In 1998, guidelines will continue to be developed and evaluated on technician resource management and situational awareness. Results from these guidelines will be made available to regulatory organizations and industry by the end of 1998.

Human Performance

In 1998, development work will continue on APMS for evaluating training program effectiveness. An advanced prototype will be completed in 1998, followed by operational evaluation and validation leading to advanced APMS specifications for airline use in 2000.

From 1998 through 2002, the fatigue program efforts will focus on validation of the computer fatigue model, utilizing fatigue risk/diagnostic tools to describe the different aviation environments, and initiating the fielding of future technological solutions for smarter system interfaces.

In 1998, research will continue on producing objective data on aircrew performance. This information will be used to produce certification guidelines and data to support regulation decisionmaking relative to aircraft design for the general aviation community.

From 1998–2002, updates to the aviation maintenance human factors issues guidebook will be published in an electronic format.

From 1998–2000 research will continue to identify and rectify error facilitators in the aircraft maintenance workplace.

Information Management and Display

In 1998, general aviation research will continue to collect scientific data to aid in identifying equipment design and pilot training initiatives. Human factors guidelines will be developed to assess cockpit integration of advanced navigation and alerting systems and to assess the effects of head–up displays in general aviation cockpits. Work will continue on developing data to assess the effects of pilot aging on performance and to determine task–based requirements for transitioning general aviation pilots into a free flight airspace environment.

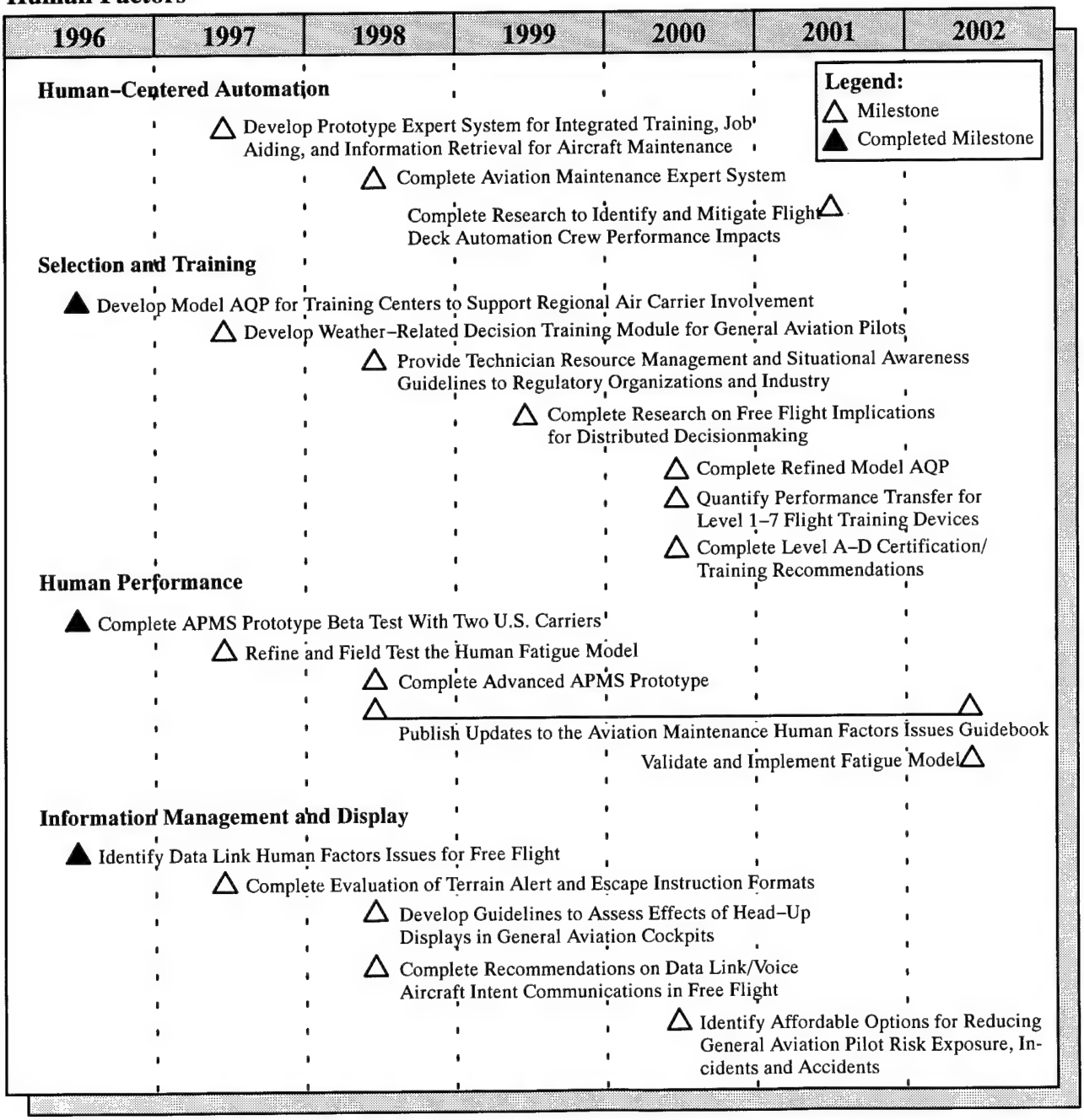
From 1998 through 2000, high fidelity simulation research will continue on relevant general aviation problems to obtain objective, scientifically derived data to aid in identifying affordable options for reducing general aviation pilot risk exposure and the number of incidents and accidents in the general aviation community. Using flight simulation, guideline data will be developed for application to the cockpit design of the advanced general aviation transport experiments aircraft.

From 1998 through 2000, work will continue to ensure that as automation and data link systems

come on–line, the human operator will obtain the proper information at the appropriate time. In 1998, recommendations will be made for cockpit displays addressing transgression of free flight alert zones. Also in 1998, recommendations will be made on procedures for communication of aircraft intent using data link, voice, or both in a free flight environment.

In 1998, several years worth of research will result in the development of human factors design guidelines for ground collision avoidance systems.

Program 081–110: Flight Deck, Aircraft Maintenance, Flight Deck/ATC System Integration Human Factors



082–110 Air Traffic Services Human Factors

Purpose: Statistically human error has been identified as a causative factor in over 65 percent of aviation accidents. The FAA has recognized the fact that proper consideration of human factors is central to the design, integration, and evaluation of effective systems; procedures; selection instruments; and training. This program will enhance the efficiency of the NAS by developing scientifically validated information that focuses on improving the performance and productivity of the human operator in the Air Traffic and Airway Facilities organizations.

The introduction of new systems and operational concepts such as centralized NAS maintenance monitoring or free flight will also result in unprecedented, and unavoidable, changes in organizational culture. This program will help to optimize human systems in the light of technological and organizational change and provide information necessary to make informed decisions regarding the best methods to implement strategic planning initiatives and achieve organizational goals.

Approach: The Air Traffic Services Human Factors program operates in consonance with other FAA strategic and program plans as well as the National Plan for Civil Aviation Human Factors.

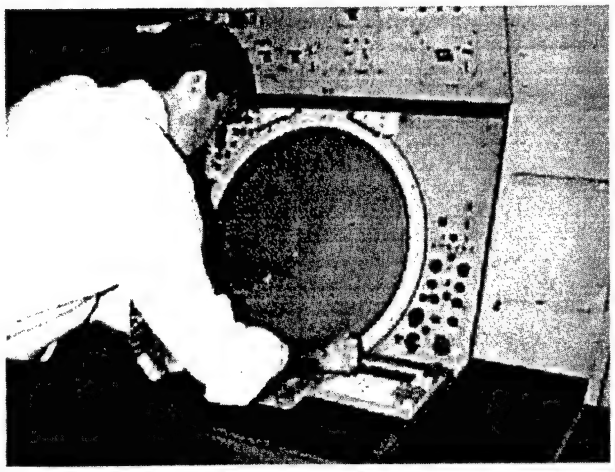
New technologies are rapidly being introduced into the NAS environment in response to the need for increased efficiency and reliability. These technologies will be catalysts for change in the roles of humans in the system. As the NAS evolves, alterations in the mixture of knowledge, skills, and abilities required of future operations personnel are virtually inevitable. Validated, performance–based selection instruments are needed in time to meet the projected demand for new controllers and technicians. This program will assess technological change by examining current NAS programs, operations planning documents and philosophy and then use this information to determine what skills are likely to be needed. Subsequent findings will be evaluated using simulation. Knowledge of anticipated skill requirements will enable the FAA to effectively accommodate evolutionary changes by developing personnel systems closely integrated with, and reflecting the operational requirements of future, highly automated ATC systems.

Assessing the impact of new technologies or procedures will require reliable methods of measuring operator/system performance. This program will develop and validate metrics that are sensitive to human performance, workload, and decisionmaking in the present, and through simulation, future NAS systems. These performance–based, feedback tools will provide FAA management with the capability to objectively predict the impact of change. Analyses of organizational and environmental factors affecting performance will also provide data leading to innovative methods for improving safety and productivity through the reduction/mitigation of system and fatigue induced human error.

Human perceptual capabilities and limitations as they relate to the design and integration of air traffic and airway facilities equipment and systems will be explored. Issues such as optimized computer/human interfaces will be tested and validated through simulation. The potential impact of automation on work activities, performance, and productivity will be studied, and appropriate guidelines will be developed to facilitate the introduction of new technologies. Reference information on human factors that can be applied in formulating future operational requirements will be developed. Recommendations to help system planners to identify and avoid design deficiencies that have the potential to induce operator error will be produced.

Assessing the impact of automation on system operators will yield insight into the complex interrelationship between humans and machines.

Measures of situation awareness will be developed and validated through simulation. Studies will be conducted to determine the optimal allocation of tasks between humans and technology. Recommendations for the design of human–centered automated systems will be developed. These guidelines will aid in the design of automation that fully supports the role of the operator and thus minimizes the probability of human error.



Safe and efficient air traffic control and management requires the acquisition and application of knowledge concerning controller capabilities and job requirements.

Related Projects: 081–110 Flight Deck, Aircraft Maintenance, Flight Deck/ATC Integration Human Factors Human Factors, and 086–110 Aeromedical Research. Capital Investment Plan programs: M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- Embry–Riddle Aeronautical University
  Daytona Beach, Florida
- Ohio University
  Athens, Ohio
- Ohio State University
  Columbus, Ohio
- Texas Tech University
  Lubbock, Texas
- University of Oklahoma
  Norman, Oklahoma
- Naval Air Warfare Center
  Orlando, Florida
- Volpe National Transportation Systems Center
  Cambridge, Massachusetts
- JIL Systems
  Washington, D.C.
- NYMA Inc.
  Washington, D.C.

Products:

- Qualitative and quantitative human factors reference information to assist in designing, integrating, and evaluating air traffic and airway facilities systems that enhance task performance, reduce workload, and promote productivity
- Analysis tools and standards for assessing/predicting operator work activity and performance
- Guidelines and models for optimally allocating operational functions and tasks to operators and their equipment
- Real–time simulations, rapid prototyping, computational models, and reference data that support FAA specifications, acquisitions, and tests for improving NAS equipment and procedures
- Capability to reconstruct en route operational errors and incidents
- Tools and reference information for improved selection and training programs

- Effective countermeasures to combat fatigue associated with rotating shift work

- Analyses that characterize miscommunications in the ATC system and offer recommendations for corrective action

1996 Accomplishments:

- Completed validation study of generic sectors (TRACON and en route) as research tools to evaluate performance metrics.

- Completed "Human Factors in the Design and Evaluation of ATC Systems" – a guide that presents human factors issues that should be considered in the design and evaluation of ATC systems and subsystems.

- Completed "Guidelines for Developing Symbols within Airway Facilities" – a guide to the design and application of symbology for use in centralized control centers.

- Completed "Human Factors Design Guide for Acquisition of COTS and NDI Developmental Systems" – a comprehensive reference tool for persons concerned with human factors issues in Airway Facilities acquisitions.

- Developed TRACON version of Systematic Air Traffic Operations Research Initiative (SATORI) that extends SATORI's incident recreation capability to the terminal environment.

- Provided evaluations of, and recommendations to remedy, potential human factors issues in the Air Traffic Control System Command Center.

- Completed analyses of pilot–controller communications issues.

- Completed organizational effectiveness study of airway facilities work flow process and prototype event ticketing implementation plan.

1997 Projected Accomplishments:

- Complete an assessment of the application of human factors design principles in the development and fielding of automated ATC systems.

- Develop human factors guidelines on the application of new technologies in centralized airway facilities control facilities.

- Develop a prototype training intervention product designed to enhance team work effectiveness in air traffic control towers.

- Recommend strategies to reduce controller reliance on flight progress strips in the en route environment of the future.

- Develop guidelines for the implementation of self–managed teams in Airway Facilities.

- Complete initial guidelines for color coding information on air traffic services system displays.

- Develop a prototype training intervention module to teach effective team decisionmaking skills in the control tower environment.

- Develop advanced simulation capability to investigate potential sources of human error in the airway facilities work environment of the future.

- Complete SATORI software enhancements that provide the capability to simulate and study human factors issues inherent in alternate separation assurance concepts such as free flight.

- Complete shift work fatigue countermeasures for controllers.

- Develop process to define predictive adaptive maintenance actions needed to prevent loss of future service.

Planned Activities:

Human Centered Automation

In 1998, research will be initiated to determine the most appropriate role for human operators in the air traffic services system of the future. This program is based on the premise that automated equipment and human operators are integral parts of a whole system. From 1998 to 2002, human–in–the–loop analyses will be conducted. Research findings will be used with next–generation ATS system projections to develop initial human/computer role relationships.

Research into human factors issues in the evolving concept of free flight will continue. Recommendations to facilitate the implementation of free flight from the human perspective will be made available on a yearly basis at least through 2001.

Selection and Training

In 1998, research will continue on validating performance–based selection instruments. An initial predictive validation study for airway facilities technicians interpersonal and teamwork predictors will be completed. New technologies will be explored for potential application in selection and training. In 1999, guidelines for en route controller team composition, training interventions, and performance metrics will be completed. From 1998 to 2001 research will also be conducted to identify appropriate selection criteria for future air traffic controllers and NAS technicians based upon the roles they will assume in the next–generation, highly automated ATC system.

Human Performance

In 1998, research into air traffic controller performance measurement will continue. Tools such as the generic sector previously developed under the auspices of this program will be applied to this effort. In 1998, the first measurement tools will be available to support human/system performance baselining. From 1998 to 2000, performance metrics will be further refined and published in handbook form.

In 1998, the effectiveness of previously developed countermeasures to rotating shift–induced fatigue will be evaluated in field settings. Operator performance will be studied as it relates to the effects of shift work. Recommendations for optimal shift schedules will be published and made available to Air Traffic Services.

In 1998, new applications for the SATORI tool will be explored. SATORI will be used to develop measures of TRACON personnel taskload and performance. Emphasis will be placed on identifying root causes of human error. In 1999, intervention strategies will be developed to help reduce the occurrence of operational errors.

Research into human error in airway facilities will continue in 1988. Particular emphasis will be placed on the future airway facilities work environment. Strategies for error prevention and mitigation will be developed in 1999.

Information Management and Display

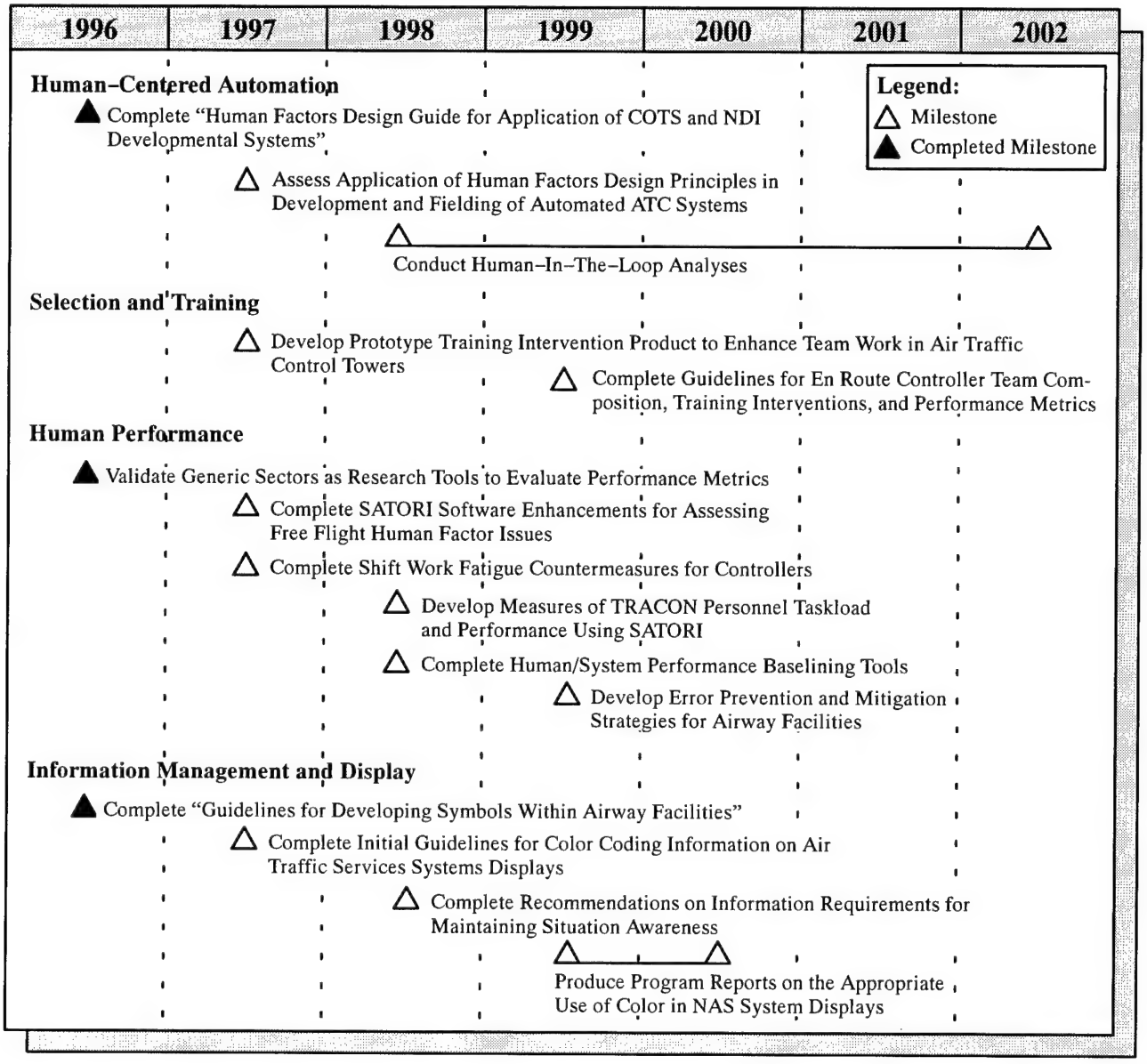
In 1998, studies into the appropriate use of color in NAS system displays will expand. Future efforts will investigate the most effective application of color in system displays. Emphasis will be placed on determining ways that color can be employed to depict an ever increasing volume and variety of information in a manner that enhances operator situation awareness and reduces the incidence of human error triggered by information overload. Program reports will be produced in 1999 and 2000.

In 1998, work will continue on developing methods to measure en route air traffic controllers' situation awareness. These measures will be available to evaluate situation awareness in alternate separation assurance concepts such as free flight or as part of the testing procedure for proposed new equipment or procedures. Recommendations will be offered regarding information requirements for maintaining situation awareness in 1998.

NAS Infrastructure Management

In 1998, research into expert systems needed in the management of NAS infrastructure service delivery will address automating many of the decision processes which today occur without automated support. Automation of activities such as determining restoration priorities and response levels dynamically, in real time, are expected to improve effectiveness and reduce potential sources of human error in the airway facilities work environment of the future.

Program 082-110: Air Traffic Services Human Factors

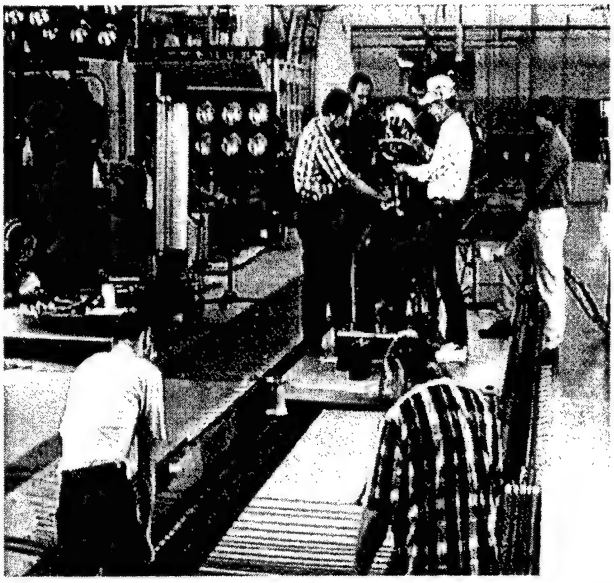


086–110 Aeromedical Research

Purpose: This program assesses types of injury and death patterns in civilian flight environments, recommends and develops protective equipment or procedures, and provides guidance to FAA regulatory and medical certification staff. The component tasks of this research identify human physiological and bioengineering failure modes in both uneventful flight and during civil aircraft incidents/accidents, while simultaneously assessing counteracting measures. The research also identifies pilot and passenger medical conditions that are incompatible with civilian flight demands. This detailed information will be used to determine if existing equipment and procedures optimally protect the human occupant; to make technical recommendations contributing to improved performance standards; and to support bioengineering, biochemistry, and biomedical aspects of certification actions and rulemaking. Prioritizing subtasks is directly responsive to the Aircraft Certification Service, the Office of Accident Investigation, the Office of Aviation Medicine, and also to unique injury and death characteristics in contemporary accidents. This prioritization allows the FAA and the National Transportation Safety Board to effect expeditious corrections of unsafe and dangerous conditions.

Approach: Tasks in this research area are derived from requirements generated within the FAA by the Aircraft Certification Service, the Flight Standards Service, the Northwest Mountain Region Transport Airplane Directorate, the Southwest Region Rotorcraft Directorate, the Central Region Small Airplane Directorate, and the Offices of Aviation Medicine and Accident Investigation. Organizations outside the FAA generating requirements through FAA channels include the National Transportation Safety Board, the military services, and the Society of Aerospace Engineers. All program activities are coordinated with government agencies and industrial representatives having related technical interests. The FAA research process ensures program coordination among the FAA performing organizations, such as the Civil Aeromedical Institute and the FAA William J. Hughes Technical Center.

This program broadly encompasses laboratory and field studies on the performance of the cabin crew, medically certified airmen, and aircraft passengers. Equipment and procedures approved by the FAA and designed to protect personnel in accident situations are also evaluated. The studies include evaluating injury mechanisms that might result from system failures or from hazardous conditions such as smoke or toxic gas environments. The studies support rulemaking or certification actions by developing performance standards and evaluating the merits, deficiencies, costs, and benefits of specific safety–related procedures and appliances. The same research generates educational spinoffs that, in cooperation with industry and airspace users, guide the aviation participant in the optimal use of safety equipment or procedures.



FAA/NASA Collaborative Light Weight Shuttle Seat Tests at the Civil Aeromedical Institute

This program consists of three research initiatives: human protection and survival; medical and toxicological factors of accident investiga-

tion; and Federal Air Surgeon program support. Protecting humans in decelerative environments, protective breathing equipment, cabin evacuation, and water survival are currently being investigated in the human protection and survival initiative. Toxicological assessment and sudden or subtle pilot incapacitation are key features of the medical and toxicological factors of the accident investigation initiative. New vision corrective methods for aviation personnel, aircraft cabin environmental hazards, and air ambulance medical requirements represent current clinical investigations under the Federal Air Surgeon program support initiative.

Related Projects: 061–110 Fire Research and Safety, 062–110 Advanced Materials/Structural Safety, 081–110 Flight Deck, Aircraft Maintenance, Flight Deck/ATC System Integration Human Factors, and 082–110 Air Traffic Services Human Factors. Capital Investment Plan programs: F–18 Aeronautical Center NAS Support Facilities, F–19 Aeronautical Center Leases, and M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- National Institute of Occupational Safety and Health (NIOSH)
  Cincinnati, Ohio and
  Morgantown, West Virginia

Products:

- Quantitative bioengineering criteria to support aircraft seat and restraint system certification
- Quantitative bioengineering criteria to support evacuation capabilities, flotation devices, and other onboard rescue equipment certification
- Quantitative biomedical criteria to support protective breathing equipment and operational procedures certification
- Quantitative biochemical and toxicological criteria supporting the use or certification of aircraft interior fire, smoke, and toxicity limits
- Revised aircrew medical criteria, standards, and assessment procedures
- Identification of medical causative factors in aviation incidents and accidents
- Occupational health assessments for unique populations in the aviation community

1996 Accomplishments:

- Developed improved child restraint options.
- Evaluated and ensured quality of international crashworthiness facilities for aircraft certification.
- Assessed the utility of platform evacuations as a substitute for standard slide evacuations in aircraft certification procedures.
- Assessed failure modes of current slides induced by passenger overcrowding.
- Developed new user–friendly design options for general aviation oxygen masks.
- Served as the national toxicology research laboratory for fatal civil aviation accidents.
- Developed special analytical detection procedures for newer mind–altering drugs.
- Developed cost–effective assessment procedure to detect a wide range of opiate derivatives concurrently.
- Evaluated efficacy of special medical certifications for pilots with cardiovascular diagnoses.

- Generated cosmic radiation exposure data that were incorporated in industry guidance materials.

- Completed questionnaire assessment of reproductive health outcomes in flight attendants as part of FAA/NIOSH cabin environmental study.

- Quantified the visual demands at the air traffic controller console.

- Provided recommendations for ergonomically designed lenses for senior air traffic controllers.

- Provided cognitive function assessment of commuter pilot group to supplement existing air carrier pilot data.

- Provided FAA and United States Department of Agriculture cargo bay environmental data to facilitate safe animal transport.

1997 Projected Accomplishments:

- Develop standards to reduce cervical spine injuries in aircraft crashes.

- Assess lower extremity injuries in "16–G" seats to develop crashworthiness design guides.

- Adapt state–of–the–art anthropometric test dummies for aircraft crash assessments.

- Develop profiles of human tolerance and behavior in high–speed civil transport rapid decompression to serve as design guides.

- Develop aircraft cabin evacuation approval guidelines that are performance based.

- Establish fully functional dual–aisle aircraft cabin evacuation research capability.

- Complete aircraft cabin environmental assessments in cooperation with NIOSH.

- Complete initial assessment of inflight communicable disease transmission.

- Develop guidelines for evaluation of laser exposures in civil aviation.

- Complete evaluations of benzodiazepines and antihistamines as factors in accident causation.

- Develop guidelines to reduce inflight sudden/subtle incapacitation.

- Develop new applications of DNA/RNA technology in accident analyses.

- Develop consensus guidelines on air ambulance medical equipment.

Planned Activities:

Human Protection and Survival

In 1998, research on cervical spine injury prevention will continue. This data will assist the FAA in developing new certification criteria based on technology improvements. In 1998, quality assurance assessments of civilian crashworthiness facilities and data outflows will continue to be provided to FAA aircraft certification staff. A key emphasis will be on conducting long–term research to improve high–altitude breathing equipment biomedical standards by 1998. Also in 1998, the previously developed prototype general aviation breathing mask will be refined, with an operational model available in 1999.

In 1998, work will continue on emergency medical equipment in air ambulances, permitting a regulatory review. This review will support specific research in advanced medical capabilities such as automatic defibrillators and other

state–of–the–art treatment modalities. Further analyses on crashworthiness and electromagnetic interference will continue through 2002. Annual recommendations will be provided to the Aircraft Certification Service and the Office of Aviation Medicine for developing standards.

The dual–aisle aircraft cabin evacuation research capability (747 fuselage) that was brought online in 1997, will permit the development of safer performance based evacuation certification procedures, as well as more effective field emergency evacuations of aircraft. The associated research will contribute to certification guideline development targeted for 1999. Concurrent single–aisle cabin evacuation research will continue to provide data on slide versus platform evacuations as alternative FAA certification approaches. Additional research flexibility using an enclosed flexible simulator permitting quick reconstruction of various seating, aisle, and exit geometries is planned for 1999. In parallel, development will continue on a dual–aisle emergency evacuation model, with first prototype expected in 2000 for possible implementation in 2002.

Medical and Toxicological Factors of Accident Investigation

In 1998, laboratory and field clinical research to determine causative human factor elements in aircraft accidents will continue. The FAA Office of Accident Investigation continually requires this data to complete its investigations of complex and diverse aircraft accidents.

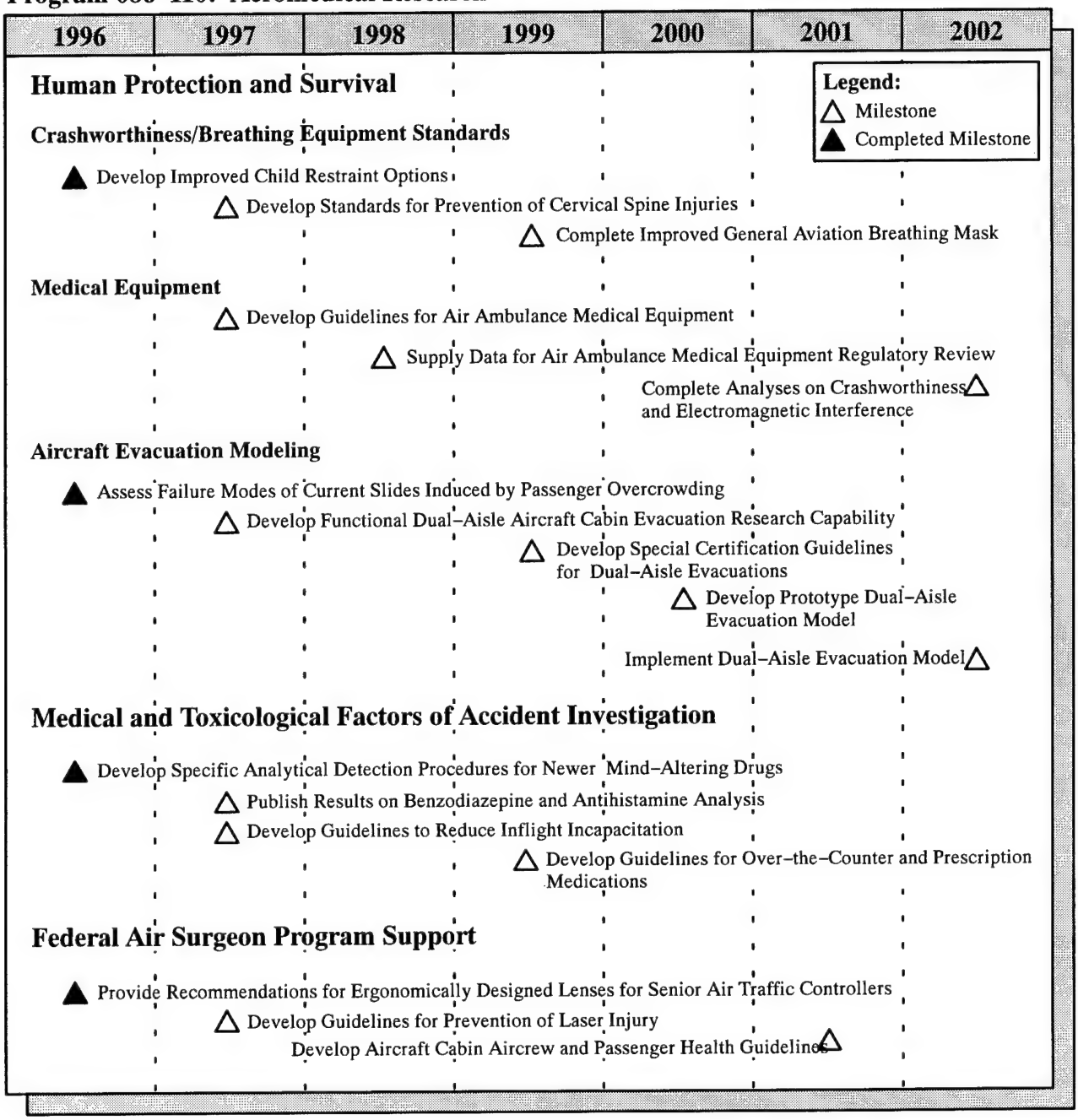
From 1998–2002, long–term research is targeted at developing updated guidance for using over–the–counter and prescription medications by civil aviation pilots.

Federal Air Surgeon Program Support

By 2001, joint FAA/National Institutes of Occupational Safety and Health research into cabin crew occupational health will determine the need for new guidelines to protect aircrew and passengers.

Other long–term research to support the FAA's mission necessitates ad hoc studies on seat and restraint systems; optimizing aircraft exit configurations; maintaining cabin safety databanks; assessing human factors in aircraft accident causation; performing toxicity studies; profiling chemical abuse in aviation; examining effects of drugs and physiological stressors on performance; evaluating new vision corrective devices; and testing medical equipment in civilian aircraft.

Program 086–110: Aeromedical Research



9.0 ENVIRONMENT AND ENERGY

The environment mission area encompasses the range of FAA activities that minimize injury, damage, disruption, and unacceptable levels of intrusion imposed on the nation's environment resulting from the operations of the federally owned or regulated components of the civil aviation system. Some major components of this mission area relate to aircraft emissions, building and operation of facilities, and storage and disposal of contaminants.

Research, Engineering and Development (R,E&D) in this mission area supports national goals to protect the environment, conserve energy, and keep the U.S. air transportation industry strong and competitive. In 1995, approximately 1.7 million individuals lived within areas considered to be exposed to significant airplane noise (a day–night average sound level of 65 decibels or more) and more than 400 U.S. airports have adopted some type of airport restriction to reduce aircraft noise or mitigate its effects. In some cases these restrictions have little impact on airport capacity, but in others the potential airport capacity has been reduced by as much as 30 percent. While there is an effort underway to ensure an early phaseout of older, noisier aircraft, there will clearly be a demand for even quieter aircraft. Air pollution from aircraft is also becoming a concern in airport expansion and proposed new airport construction in areas designated moderate or severe nonattainment for pollutants. New aircraft and new aircraft engine types offer potential relief to the public; however, substantial research, engineering and development will be required to support future regulations.

The future aviation system will be one that is a "good neighbor" to the people living near airports. The challenges revolve around issues associated with how this good neighbor policy is implemented. While noise and pollution are the primary challenges, other issues associated with the atmospheric effects from new aircraft types, and new or alternative fuels, will require analysis and investigation.

The value gained from research in the environment area will derive from reducing both direct and indirect costs associated with meeting the national goals. Discovering ways to build quieter engines that have fewer noxious emissions is the direct approach. The indirect approach is to develop ways to use existing equipment more appropriately. Both approaches are reflected in this mission area's programs.

A benefits assessment associated with these research efforts is underway. Noise reduction assessment strategies will be built around a quieter technology.

The FAA's policy for environment and energy issues is to provide strong leadership in mitigating aviation's significantly adverse impact on the public, consistent with sound energy planning and an effective aviation system. The FAA has adopted the following strategies:

- Lead a cooperative development effort that balances noise reduction with adequate airport capacity.
- Manage FAA activities to minimize significantly adverse environmental consequences and comply with all federal statutes.
- Develop sound aviation energy plans.
- Stimulate private industry and government–sponsored research to reduce noise, emissions, and energy consumption by the aviation sector.

The Research, Engineering and Development Plan for the Environment and Energy area responds directly to these strategies, and to the recently passed Airport and Airway Safety,

Capacity, Noise Improvement, and Intermodal Transportation Act of 1992, and the Clean Air Act Amendments of 1990.

Table 9–1, Major Environment and Energy Products, provides a quick overview of major environment–enhancing products from R,E&D research efforts.

Table 9–1. Major Environment and Energy Products

Program Number	Program Name	Major Products
091–110	Environment and Energy	• Mathematical models to compute the impact from aviation noise for both airports and heliports • Certification standards for new technology aircraft including ultra high–bypass engines and high–speed civil transports • Studies to identify feasible technologies leading to potential noise certification standards

9.1 Environment and Energy Program Descriptions

091–110 Environment and Energy

Purpose: This research supports the FAA Strategic Plan to provide strong leadership in mitigating the significantly adverse environmental impacts of civil aviation. This program will develop various tools and methods used to evaluate the environmental impact from alternative aviation policies and strategies. The focus will be on controlling both aviation noise, a major constraint on airway and airport capacity, and aircraft exhaust emissions in the upper atmosphere, a growing public concern. The program will also ensure FAA compliance with all federal environmental statutes, such as the Airport and Airway Safety, Capacity, Noise Improvement, and Intermodal Transportation Act of 1992 and the Clean Air Act Amendments of 1990.

Approach: Environment and Energy R,E&D consists of the following major disciplines: aviation environmental analysis; aircraft noise reduction and control; aircraft engine emissions reduction and control; and FAA energy conservation.

Aviation Environmental Analysis

The aviation environmental analysis and the aircraft noise reduction and control activities will eliminate many constraints on aviation growth, especially on airport capacity, through technology and expertise aimed at mitigating or controlling aircraft noise. These activities will include continually updating and improving the integrated noise model, the heliport noise model, the area equivalent method, and the nationwide airport noise impact model. These noise models are used to predict and assess the impact from FAA policies and federal actions. Research will be conducted to develop better tools for assessing the costs and benefits associated with noise reduction and control activities.

A cooperative research program with the National Aeronautics and Space Administration will investigate human response to noise levels as part of a longer range program aimed at developing a better understanding of community reaction to aircraft noise exposure.

Aircraft Noise Reduction and Control

The FAA has entered into a joint research program with NASA research centers to investigate technology advances in source noise reduction. The research will include engine design parameters, advanced acoustic absorption materials, and active noise control devices. Aircraft technology advances will include high lift devices and methods to reduce airframe–generated noise.

Noise testing will be conducted to simplify existing certification procedures and develop new procedures for future aircraft. Noise requirements for heavy helicopters, advanced subsonic transports, high-speed civil aircraft, and hypersonic research vehicles will be evaluated in cooperation with industry.

Aircraft Engine Emissions Control

The FAA will undertake a joint high altitude pollution research program with NASA's research centers to investigate new technologies in jet engine combustor designs that reduce engine emissions, specifically nitrogen oxide emissions. These emissions generate particular concern due to their potential impact on the upper atmosphere. The results from these investigations will be used in developing future engine emission regulations and international standards. Studies with NASA will also investigate both current subsonic and high–speed civil transport's (HSCT) effect on the

ozone layer and global climate change. These studies are intended to determine the HSCT's future viability and the need for aircraft engine emission standards at cruise altitude conditions.

Energy Conservation and Aviation Energy Emergency Contingency Planning

This program will support achieving a 30 percent energy use reduction or a 30 percent increase in efficiency in FAA buildings by 2005 as compared to 1985. It seeks to minimize energy use in federal facilities to comply with Executive Order 12759. The FAA also will review and evaluate the present energy management reporting system. Based on this review, the system will be upgraded and enhanced, or replaced with another tracking and reporting system. A user training program will also be developed. The reporting requirement is mandated by Executive Order 12759 and the National Energy Conservation Policy Act, as amended.

Related Projects: 022–140 General Aviation and Vertical Flight Program, 024–110 Aviation System Capacity Planning, and 025–130 Air Traffic Models and Evaluation Tools. Capital Investment Plan programs: M–03 Capital Investment Plan (CIP) System Engineering and Technical Assistance.

University/Contractor Support:

- NASA Research Centers
- Volpe National Transportation Systems Center
  Cambridge, Massachusetts

Products:

- Mathematical models to compute the impact from aviation noise for both airports and heliports
- Mathematical models to compute aviation contributions to airport and upper atmospheric air pollution
- New, simplified, aircraft certification procedures for contemporary airplanes and helicopters
- Handbooks and guidance material for FAA field personnel involved in aircraft certification
- Certification standards for new technology aircraft including ultra high–bypass engines and HSCT's
- Studies to identify feasible technologies leading to potential noise certification standards

1996 Accomplishments:

- Developed noise impact routing computer model for assessment of airspace design.
- Published report assessing noise reduction technologies for propeller–driven airplanes and rotorcraft.
- Published handbook on engine exhaust emissions certification procedures.
- Reported on achievement of the interim goals of the Subsonic Noise Reduction Program.

1997 Projected Accomplishments:

- Harmonize FAA noise certification regulations with European joint aviation authorities.
- Develop simplified noise certification procedures for large helicopters.

- Initiate joint FAA/NASA research program to identify noise abatement technologies for rotorcraft.

- Publish advisory circular of aircraft engine emission certification levels and limits.

- Produce integrated noise model Version 5.1, an advanced mathematical model to compute aircraft contributions to airport and heliport noise exposure.

Planned Activities:

Aviation Environmental Analysis

The system of airport noise analyses and impact assessment tools and processes will be expanded in 1998 to include major air traffic management and airspace improvement programs. Also, vertical flight noise assessment tools will be completed for use in heliport/vertiport development. Additionally, research will begin on developing a non-airport noise assessment prediction capability. A prototype noise assessment tool will be developed in 2000 for field validation in 2002.

Aircraft Noise Reduction and Control

From 1998–2000, the FAA/NASA research effort assessing subsonic jet noise reduction technologies will continue. Annual reports will be published to describe results, track program progress, and identify promising technologies. In 2000, the research will identify economically feasible technologies for U.S. manufacturers to develop quieter airplanes.

From 1998 and continuing beyond 2002, an FAA/NASA research effort will assess rotorcraft noise reduction technologies. Annual reports will be published to describe research results, track program progress, and identify promising technologies.

Starting in 1998 and continuing through 2001, an FAA/NASA research effort will identify promising noise abatement technologies for propeller–driven airplanes.

Aircraft Engine Emissions and Control

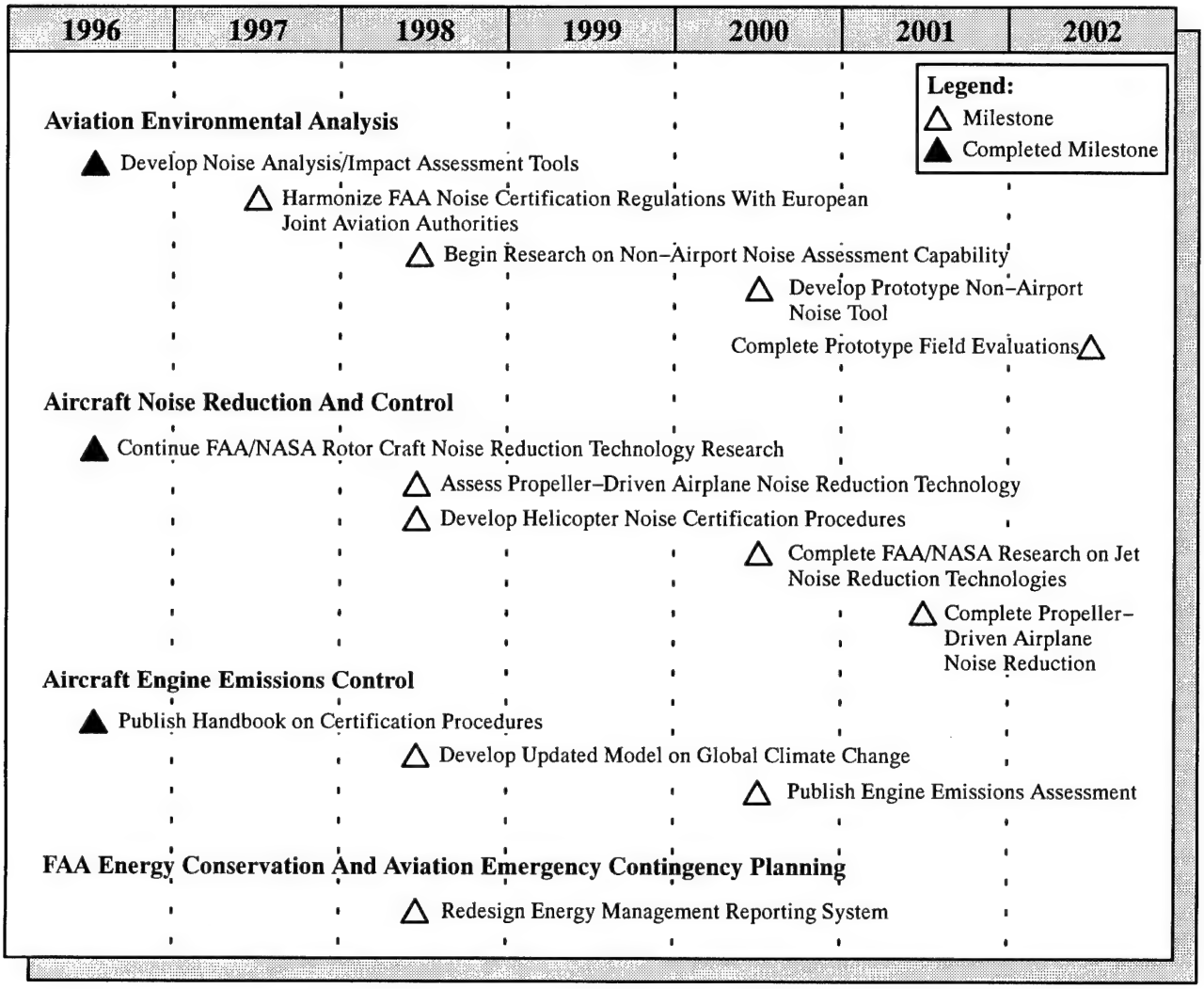
Pursuant to the Clean Air Act, the FAA plans to update the Federal Aviation Regulations on aircraft emissions in 1998. The FAA's data base on emissions characteristics will be expanded by collecting data on new technology and newly certified engines.

In 1998, an updated version of the global aircraft emissions forecasting model will be developed to predict the atmospheric effects from subsonic and HSCT emissions on global climate change. An assessment will be published in 2000 with research continuing beyond 2002 to develop new engine emissions technologies. The final product will be using these analyses and research efforts to develop engine emissions certification standards and other regulatory actions.

Energy Conservation and Aviation Emergency Contingency Planning

In 1998, a redesigned energy management reporting system will be distributed in the field for the assessment of the agency's energy and water conservation measures.

Program 091–110: Environment and Energy



APPENDIX A

Innovative/Cooperative Research

The Innovative and Cooperative Research program provides for research, engineering, and development (R,E&D) partnerships with industry, academia, and other government agencies as a means for leveraging FAA R,E&D investments with complementary investments from these other sectors. The R,E&D products developed through these partnerships are essential for the safe, efficient, and cost–effective operation of the air transportation system in the U.S. Products developed in the recent past include:

- A crushable pavement for runway ends to safely arrest overrunning aircraft.
- A device for screening bottled products in passenger carry–on baggage to assure that the bottles do not contain explosives.
- A capability based on the global positioning system to safely land aircraft in inclement weather conditions.
- A multifunction terminal area radar capability that can detect and track both aircraft and weather systems.

The program area also makes essential contributions to the quality of the FAA R,E&D program by:

- Providing a ready means for industry to contribute R,E&D solutions through cooperative research agreements and Small Business Innovation Research contracts.
- Fostering the insertion of innovative new technologies and concepts through partnerships with academia and industry.
- Assuring a continued supply of young scientists and engineers interested in aviation research and able to contribute.

This Page Intentionally Left Blank

101–110 Transportation Research Board (TRB)

Purpose: This program stimulates research concerning the nature and performance of aviation transportation systems, disseminates the information produced by the research, and encourages applying appropriate research findings. This research influences the FAA's future policy direction. The TRB is a National Research Council unit that serves the National Academies of Sciences and Engineering. The products from this research help the public sector focus on technical and management innovations developed by the academic and private sectors to resolve current and future critical issues. The TRB also provides an independent perspective on means that could be used to improve safety, manage the national aviation system, increase capacity and productivity, and stimulate interest in highly qualified students to pursue careers in aviation.

Approach: The FAA determines specific research to be conducted and awards research contracts to the TRB. This program is carried out largely by committees, task forces, and a panel staffed by industry, public officials, and university experts who serve without compensation. The FAA provides one or more analysts to participate on these committees, task forces, and panels. The Board's efforts also include research on aviation's future by conducting an annual Graduate Research Award Program. This program focuses on technical and management innovations for civil aviation facilities in the next century and other special research projects to further the national aviation system's safety and efficiency. Completed products are normally transmitted to the FAA, industry, and general public as an official TRB circular. The Graduate Research Award Program papers are also presented at a special session of the annual TRB meeting.

101–120 FAA/NASA Joint University Program

Purpose: This program conducts research germane to the entire spectrum of National Airspace System activities at three recognized American universities in cooperation with NASA. These three universities are the Massachusetts Institute of Technology, Ohio University, and Princeton University. The program also assists in educating professional personnel needed to develop and manage the future NAS components. Solutions to large scale systems problems related to the national air transportation system ultimately come only after the technological foundations have been laid through basic research. The Joint University Program has provided an interdisciplinary team approach to research and education in those areas necessary for fundamental advances at the forefront of aviation technology. This program provides results to the FAA from scientific and technology advances in numerous disciplines including air traffic management, atmospheric hazards, avionics, human factors, flight control theory, and aircraft safety. The program is a source of talented engineers and scientists skilled in aviation–related fields. Plans for the immediate future include transitioning from sponsorship by NASA Langley to NASA Ames Research Center and the inclusion of its affiliated West Coast universities.

*101–130 Small Business Innovative Research (SBIR) Program

Purpose: This program stimulates technological innovation, uses small business to meet federal research and development needs, increases private sector commercialization of innovations derived from federal research, and encourages participation by small disadvantaged companies in developing technological innovations. The SBIR program is congressionally mandated by the Small Business Research and Development Enhancement Act of 1992 (Public Law 102–504). The program is funded through project funds that reside in other R,E&D programs. By virtue of its FAA–wide scope, the SBIR program benefits the entire program spectrum that makes up the national air transportation system. Financial and technical resources can be applied to these programs in a timely and cost–effective manner. By enabling small, high technology companies to start up and prosper, the SBIR contributes in a larger sense to the domestic economy and technology infrastructure.

Approach: Research topics are solicited from the various organizational elements throughout the agency. These topics then appear in an annual solicitation for proposals issued by the Department of Transportation. Individuals who submit the topics evaluate the proposals, and winners are chosen based on evaluations and agency needs. Firms selected to receive an award embark on the following three–phase process: Phase I – conduct feasibility–related experimental or theoretical research for R,E&D efforts up to $100,000; Phase II – perform principal research effort (a performance period of approximately 2 years and funding up to $750,000); and Phase III – perform commercialization of the research conducted under Phases I and II (no funding limit).

*101–140 FAA/NASA Cooperative Programs

Purpose: This program provides a synergistic and cost–effective R,E&D program with NASA in areas of mutual interest. The program enables the FAA to better respond to the goals and objectives of the FAA Strategic Plan through access to and use of unique NASA facilities and other resources. This cooperative effort provides substantial economic benefit and efficiency to the FAA's continuing research and development activity. FAA field offices have been established at NASA Ames and Langley Research Centers to coordinate, facilitate, and support joint research projects of mutual interest. In addition, these field offices propose new research projects and advise appropriate organizations in the FAA when new research areas of interest to the FAA are being considered by NASA. The field offices represent a unique FAA resource due to their proximity and access to NASA facilities, their knowledge of NASA personnel and ongoing NASA research, and their understanding of FAA needs. Benefits realized through this cooperative relationship include an enhanced perspective on joint research activities, reduced duplication of similar efforts, and conservation of scarce funds and resources.

Approach: FAA/NASA cooperative activities are divided into broad areas of research defined by memoranda of understanding. Existing FAA/NASA memoranda of understanding include: human factors, severe weather, cockpit/air traffic control integration, airworthiness, environmental compatibility, airspace system user operational flexibility and productivity, and program support. Specific cooperative activities are

* *Will be combined into new programs 101–205 NASA Field Offices and 101–210 R&D Partnerships in 1998.*

accomplished via memoranda of agreement relating to one or more memoranda of understanding. Memoranda of agreement incorporate statements of work for specific research projects, establishing the objectives and responsibilities of each agency. Individual research projects are negotiated to meet program–specific requirements, foster cooperative interaction, and share resources and unique facilities.

Most recently, in 1995, a memorandum of understanding on airspace system user operational flexibility and productivity was signed for air traffic management. This agreement, based on an FAA/NASA integrated product team concept, covers airspace system user operational flexibility and productivity research. The goal in this latest memorandum of understanding is to combine the FAA's expertise in air traffic management and NASA's expertise in aeronautics to achieve an integrated air–ground system.

Research in the seven memoranda of understanding includes:

- Human factors research develops technology to improve the efficiency and safety of air and ground–based flight–related operations by reducing the consequences of human error.

- Severe weather research develops technology to improve aircraft operations safety in hazardous weather conditions.

- Cockpit/air traffic control integration research pursues aircraft/air traffic control related technologies and techniques to increase capacity and improve safety and efficiency of flight operations in the national airspace system.

- Airworthiness research develops technologies that support new aircraft development and certification and ensures the continued safe operation of existing aircraft.

- Environmental compatibility research develops technologies to reduce or eliminate noise and emission concerns in aircraft operations.

- Airspace system user operational flexibility and productivity research develops technologies that meet the needs of airspace users for safe, efficient, and cost–effective flight operations.

- Program support covers operation and maintenance of the FAA field offices located at NASA Ames and Langley Research Centers, including support of new, innovative individual and joint research projects and other broad interest FAA/NASA programs such as the Aviation Safety Reporting System (ASRS).

101–150 University Fellowship Research Program

Purpose: This program expands the education and research activities associated with emerging concepts and technologies related to air traffic control, aviation safety, system capacity, and security systems. A corollary purpose is to assist in attracting and recruiting qualified graduates to work for the FAA. The University Fellowship Research Program is conducted via a long–term grant award to Rutgers University. The Program gives well-qualified and highly motivated graduate students an opportunity to conduct thesis research on FAA topics of interest while working with FAA engineers, scientists, and university professors. This program

provides technology advancements to enhance the National Airspace System capability and improve aircraft safety and security. Educational opportunities will be provided for talented engineers and scientists with the skills, interests, and abilities necessary to accomplish this work.

Approach: Participants in the program engage in formal course work at their respective universities and conduct research in FAA laboratories on FAA–directed topics. The program includes expanding universities' education and research activities in areas related to air traffic control systems and aircraft safety. Companion education and training activities are included to develop and enhance existing capabilities within the FAA. These activities, held at FAA sites, include semi–annual conferences to review progress achieved to date and solicit new direction for fellowship research.

*101–160 Technology Transfer Program

Purpose: This program promotes technology sharing among government, industry, and academia, and it transfers FAA R,E&D results into the mainstream of the United States economy. Technology transfer refers to the process by which existing knowledge, facilities, or capabilities developed under federal funding are used to fulfill public or private domestic needs. The United States is facing increasing challenges to its worldwide technical and economic primacy. A major problem in meeting these challenges is the extremely small return on the $60 billion annual federal research and development investment. The central obstacle to increasing this return has been identified by Congress as the federal government's inability to transfer a significant portion of federally funded research and development results into the private sector for commercialization. Several key pieces of legislation have been enacted to overcome this obstacle.

The Stevenson–Wydler Technology Innovation Act of 1980 (Public Law 96–480) mandated that all federal laboratories assume technology transfer as a primary mission area. It provided the legal foundation for a technology transfer infrastructure within the federal laboratory system and established an Office of Research and Technology Applications at every federal R&D activity.

The Technology Transfer Act of 1986 (Public Law 99–502) established the formal tools and mechanisms to accomplish technology transfer and mandated the following elements: (1) establish cooperative research and development agreements between federal and non-federal parties; (2) establish the Federal Laboratory Consortium, an affiliation of government laboratories to support the technology transfer mission; and (3) provide a cash incentive program to promote and encourage individual participation in meaningful technology transfer projects through awards and royalty sharing.

Executive Order 12591 of April 10, 1987, directed all federal laboratories to establish Technology Transfer Programs. In response to the laws and the Executive Order, the FAA developed Technology Transfer Order 9550.6 of October 30, 1989, which promulgates the FAA's Technology Transfer Program.

Approach: The FAA Technology Transfer Program goals are to: create partnerships with private industry which lead to private sector commercialization while meeting FAA mission

* *Will be combined into new programs 101–205 NASA Field Offices and 101–210 R&D Partnerships in 1998.*

objectives, identify and promote intellectual property opportunities through patents and licensing agreements, leverage the federal return on R&D investments, reward technical creativity, provide a seamless mechanism for the exchange of technical knowledge and expertise and comply with the letter and the spirit of federal technology transfer legislation.

*101–170 Independent Research and Development (IR&D) Program

Purpose: This program encourages contractors to perform independent research and development on topics relevant to the FAA's long–term interests. This activity is a joint government/industry program legislated by Public Law 102–190.

The government recognizes IR&D as a necessary cost of doing business in a high technology environment and provides for cost recovery in the Federal Acquisition Regulations. Major contractors doing IR&D projects are requested to provide the FAA with information describing these projects. Descriptions also are submitted to the Defense Technical Information Center (DTIC) on a yearly basis in the prescribed format.

New IR&D legislation no longer requires yearly on–site review evaluations, but encourages IR&D technical interchange meetings. These meetings are arranged by mutual agreement between the contractor and government to review and discuss a focused set of technology and/or product development projects. The purpose of these meetings is to: promote face–to–face detailed technical interaction between the contractors and the government; provide opportunities for government presentations on relevant technical needs and activities; and provide opportunities for government participants to visit the contractor's facilities and operations.

The IR&D program's benefits are:

- Access to industry views about technical and business directions for the future.
- Exposure to a broader range of technical options in an R&D project's early phases.
- An available pool of qualified contractors who can respond competently and competitively to government requirements.
- Spreading the risk and cost of encouraging new ideas and concepts.
- An enhanced capability for continuous innovation to meet technical challenges for the future.

Approach: The Office of Research and Technology Applications has access to the DTIC proprietary IR&D data base. During the year, customized data base searches are performed for the R,E&D services. Upon request, the IR&D program office will arrange technical interchange group meetings to explore any company's IR&D projects. Further contacts may then be made with the principal investigators to monitor the research results and their potential use to the FAA.

* *Will be combined into new programs 101–205 NASA Field Offices and 101–210 R&D Partnerships in 1998.*

*101–180 Aviation Research Grant Program

Purpose: This program provides the FAA with the ability to support and access innovative, advanced research to support the FAA mission of improving aviation safety, security, capacity, and the environment, resulting in a safer and more efficient air transportation system. This goal is accomplished by awarding aviation research grants or cooperative agreements to colleges, universities, and nonprofit research institutions to perform long–term research of potential benefit to the aviation industry. In the case of Aviation Security, grants may be issued to profit research organizations. This program also allows the FAA to greatly increase the aviation research talent base available to the FAA and the aviation community, a valuable resource necessary to achieve the vision for the aviation system of the future.

Legislation: FAA R,E&D Reauthorization Act Title IX, Public Law 101–508 Aviation Security Improvement Act, Public Law 101–604

Collectively, the legislation directs that:

- Authority be given to the FAA to award single– and multi–year research grants or cooperative agreements to colleges, universities, and other research institutions
- Research topics shall include, but not be limited to, ATC automation; aviation applications of artificial intelligence; aviation and air traffic control simulation and training technologies; human factors; airport and airspace planning and design; airport capacity enhancement; aviation security; and aircraft safety.
- At least 3 percent of the total FAA R,E&D budget be devoted to fund the research grant program.
- The FAA shall contribute to building an aviation research talent base of technical professionals trained in the sciences, engineering, and mathematics, and mechanics related to aeronautics and aviation.

Approach: Program execution is guided by a set of established laws, regulations, policies, and internal and external procedures which are updated continuously. A process for advertising, soliciting, and evaluating research proposals was developed, initiated, and is continually measured to assure the process is effective and efficient. This process, and the process for awarding, administering, and closing out grants, is detailed in FAA Directive 9550.7, Aviation Research Grants. A database has been established to ensure that proposals and grant awards are properly tracked with key events monitored. The solicitation is available electronically on the FAA Technical Center World Wide Web server at URL http://www.tc.faa.gov or anonymous FTP at ftp.tc.faa.gov. Movement is towards a totally electronic process for grants administration, including award. A network of proposal technical evaluators and grant technical monitors has been established.

One hundred forty–five grant awards have been made since program inception. These grants are funded through individual FAA program support. Program funded grants are supported through the budgeted funds of the technical programs and support research responsive to the needs of a specific R,E&D program. The Aviation Research Grant Program assists the R,E&D program offices in achieving their goals.

* *Will be combined into new programs 101–205 NASA Field Offices and 101–210 R&D Partnerships in 1998.*

APPENDIX B

Research, Engineering and Development (R,E&D) Management, Plan, Control, and Support

A process was initiated in 1990 to provide more in–depth analysis and control for R,E&D activities. The process emphasizes developing a systems engineering approach to define, implement, and manage the research required for National Airspace System (NAS) development. This process' maintenance and enhancement is critical to the R,E&D program efficiency and effectiveness. Supporting the R,E&D infrastructure contributes to virtually every project within the R,E&D environment.

The R,E&D infrastructure provides the vehicle to ensure that the total R,E&D program is conducted as a cohesive, integrated entity and permits evaluating progress across the thrust areas. This is critical due to the integrated nature, both technical and fiscal, of the individual R,E&D projects with each other, with the future aviation system, and with the Aviation System Capital Investment Plan.

R,E&D resources are required for the following efforts:

Research, Engineering and Development Plan

The Plan for Research, Engineering and Development is published in response to Section 44501 of Title 49, United States Code (Transportation). The Plan is published annually and describes the research, engineering, and development projects the FAA Administrator considers necessary to carry out the FAA's mission.

R,E&D Management, Plan, and Control

The R,E&D management and control process and automated support system will be maintained, refined, and further integrated into the R,E&D planning and budgetary processes. Specific products will include publishing the annual R,E&D Plan, associated report to Congress on R,E&D accomplishments from the previous year, and technical/engineering schedule support for the R,E&D program.

R,E&D Advisory Committee

The committee will provide the agency with reports, advice, and recommendations regarding the needs, objective, plans, approaches, contents, and accomplishments with respect to the aviation research program. The committee considers aviation research needs to support the FAA mission and addresses such areas as airport capacity, system safety, aircraft safety, aeromedical research, aviation security, and future ATC technology.

R,E&D Program Support

Provides for in–house support for system engineering and development, international requirements, and NAS program analysis activities.

Technical Laboratory Facility

The FAA Technical Center operates and maintains laboratory facilities, including the National Simulation Capability (NSC), to perform test, evaluation, and integration efforts. Funding is required for maintenance, software licensing fees, support costs, and other costs associated with operating the technical laboratories.

Federally Funded Research and Development Center

The Federally Funded Research and Development Center (FFRDC) provides the FAA with a long–term essential research, development, and engineering resource offering an extensive corporate knowledge base and high–quality expertise. The FFRDC organization operates in the public trust with access to sensitive or proprietary data, providing a quick–response capability for conflict free, objective, independent analyses. The FFRDC offers the detailed research necessary to meet the FAA's needs for new technology in the area of air traffic management, including new developments in traffic flow management, navigation, separation assurance, and surveillance technology.

APPENDIX C

List of Acronyms and Abbreviations

A

AAIT	Air Accident Investigation Tool. The AAIT is a set of computer based models that allows an investigator to key critical information about a specific aircraft and have the tool suggest reasons for the accident.
AC	Advisory Circular. The AC is a series of external FAA publications consisting of all non–regulatory material of a policy, guidance, and informational nature.
ADL	Aeronautical Data–Link. ADL is a digitized communication system that augments verbal with electronic written communication.
ADR	Automated Demand Resolution. The ADR function is an air traffic management tool that provides automated capability to generate real–time alternative national management strategies that reflect en route congestion, airport dynamics, weather conditions, and military airspace usage.
ADS	Automatic Dependent Surveillance. ICAO has defined ADS as a surveillance technique in which aircraft automatically provide, via a data link, data derived from on–board navigation and position–fixing systems, including aircraft identification, four–dimensional position, and additional data as appropriate.
ADS–B	Automatic Dependent Surveillance Broadcast. ADS–B is the automated broadcast of information made available from the ADS system for use by non–ADS equipped aircraft.
AERA	Automated En Route Air Traffic Control. AERA is an air traffic management tool that will provide a number of safety and flight plan management improvements. AERA will be capable of projecting and analyzing a flight route or flight route change, repeatedly looking ahead for possible conflicts, and notifying controllers when a conflict no longer exist. It will serve as an automation tool integrator and lay the framework for the future air traffic control system where air traffic management responsibilities are shared between controllers and pilots.
AF	Airway Facilities. AF is the FAA organization that maintains all equipment and facilities (buildings, access roads, antenna towers, etc.) that support the FAA's air traffic control capability. AF is responsible for modernizing or replacing these facilities and constructing new facilities.

AGATE — Advanced General Aviation Transport Experiments. The AGATE project establishes air, ground, and training work packages for the NASA/FAA/industry effort to support experiments in the general aviation/vertical flight area.

AGFS — Aviation Gridded Forecast System. The AGFS is a forecast system that is specifically designed to support advanced weather forecasts. The three dimensional basis of the system grid uses aviation–relevant parameters to develop icing forecasts, en route and transition turbulence, ceiling and visibility, thunderstorm and microburst prediction, and wind analysis and forecasting.

AIDC — Air Traffic Services Interfacility Data Communication. The AIDC will exchange flight planning information between adjacent foreign flight regions. It eliminates time–consuming manual voice inputs from controller coordination activities across international boundaries.

AMASS — Airport Movement Area Safety System. AMASS augments ASDE–3 (See ASDE below) with a state–of–the art alerting system. In less than one second, AMASS tracks all ground operations, compares each movement, and automatically provides visual and audio alert of potential conflicts or even the slightest deviation in airport operations.

AMSS — Aeronautical Mobile Satellite Services. AMSS is the oceanic mobile satellite service.

AOAS — Advanced Oceanic Automation System. The AOAS project is aimed at developing new abilities to increase oceanic air traffic capacity and efficiency without degrading safety. AOAS will be able to provide reliable and timely position information, reduce aircraft separation standards, and allow oceanic users to optimize fuel efficiency, reduce travel times, and have access to preferred takeoff times and flight paths.

AOC — Aeronautical Operational Control. AOC is an airline's center for all operational information including plane availability, flight, weather, and maintenance that would affect ongoing operational decision making.

APMS — Automated Performance Measurement System. APMS is a desktop computer–based ground analysis station that will provide for the capture, storage, retrieval, and interpretation of in–flight digital flight information.

AQP — Advanced Qualification Program. The AQP program establishes training criteria used by airlines to test pilots in simulated flight to ensure the effectiveness of the training.

ARTCC — Air Route Traffic Control Center. The ARTCCs provide en route services for a large geographical area to aircraft between the departure and arrival phases of flight. The primary role of the ARTCC is to provide a safe, orderly, and expeditious traffic flow through the NAS. Services include separating instrument flight rules aircraft, monitoring traffic flow and implementing traffic management initiatives, and issuing traffic and weather advisories.

ARTS	Automated Radar Terminal System. ARTS is a generic term for the functional capability afforded by several radar terminal automation systems. Each system differs in specific capabilities. ARTS plus a suffix denotes a specific system.
ASDE	Airport Surface Detection Equipment. The purpose of ASDE is to detect all principal features on the surface, including vehicular traffic, and to present the entire picture in real–time on a radar console in the control tower. The ASDE–3 system is an advanced digital radar system that penetrates rain, snow, and fog to carry out this effort.
ASI	Aviation Safety Inspector.
ASR	Airport Surveillance Radar. ASR is FAA's short range radar for terminal air traffic control.
ASRS	Aviation Safety Reporting System. The ASRS is an anonymous and voluntary reporting system that allows all aviation–related personnel to report any safety related event in a standardized manner to the FAA. The system is located at NASA Ames Research Center, Moffett Field, CA.
ASTA	Airport Surface Traffic Automation. ASTA is a comprehensive surface traffic automation capability to detect and prevent runway incursions and expedite surface traffic.
ATC	Air Traffic Control. ATC is a service provided by the FAA to promote the safe, orderly and expeditious flow of air traffic.
ATCSCC	Air Traffic Control System Command Center. The ATCSCC provides daily national oversight over the total air traffic management system including the continental US and neighboring oceanic airspace.
ATCSP	Communication protocol and set of standards for integrating air traffic related simulators.
ATIS	Automated Terminal Information Service. ATIS broadcasts information on a discrete frequency on airport weather, runway and approaches in use, and airport conditions.
ATM	Air Traffic Management. ATM is the composite process of air traffic separation and the allocation of air traffic flows. This composite process ensures safe, efficient and expeditious aircraft movement.
ATMS	Advanced Traffic Management System. This system develops automated capabilities to enhance and better manage system capacity resources and eliminate unnecessary flow restrictions.
ATN	Aeronautical Telecommunications Network. ICAO has defined ATN as an internetwork architecture that allows ground, air–ground, and avionic data subnetworks to operate together by adopting common interface services and protocols.

AWDL — Aviation Weather Development Laboratory. The National Center for Atmospheric Research laboratory develops, tests, and evaluates aviation weather products. It is located in Boulder, CO.

C

CAT — Computer Assisted Tomography. CAT is a series of computer–assisted images from X–ray slices along the center line of the X–ray target, such as a piece of luggage, which may be used to form a three dimensional image .

CDM — Collaborative Decisionmaking. CDM provides for a more direct dialogue and interaction between the FAA and system users. See 021–110.

CDTI — Cockpit Display of Surface Traffic Information.

CHI — Computer/Human Interface. The CHI refers to all those aspects of system design (both hardware and software) that influence the user's participation. These may include ergonomics, speed, accuracy, fatigue, and task overload.

CIP — Capital Investment Plan. The FAA has instituted a process for capital investments based on mission needs and future concepts. The Aviation System Capital Investment Plan (CIP) is a result of this effort.

CNS — Communications, Navigation, and Surveillance

CNS/A — Communications, Navigation and Surveillance Avionics. CNS/A refers to the electronic and electrical equipment that supports the CNS functionalities.

CRDA — Cooperative Research and Development Agreement. The CRDA provides a means for developing R,E&D partnerships with industry, academia, and other government agencies.

C/SOIT — Communications/Surveillance Implementation Team. The C/SOIT is composed of a multidisciplinary group of FAA and industry personnel that will bring C/N/S technologies together in a manner leading to development of a global CNS/ATM system.

D

DGPS — Differential corrected Global Positioning System. This is a GPS system (see definition below) that has been improved by the use of additional techniques to provide a more accurate position definition.

DME — Distance Measuring Equipment. Equipment used to measure the slant range distance from the DME navigational aid.

DOD — U.S. Department of Defense.

DOTS — Dynamic Ocean Tracking System. DOTS is an F&E program that generates flexible aircraft flight paths to take advantage of favorable weather conditions and provide traffic managers with a traffic display system.

DSV — Digital Systems Validation. DSV research will address airworthiness standards and techniques as they relate to emerging, highly complex, software–based digital flight controls and avionic systems. Primary emphasis will be on flight safety systems pertaining to the application of this technology to flight critical systems.

DTIC — Department of Defense Technical Information Center. The DTIC is responsible for acquiring, storing, retrieving and disseminating defense–related scientific, technical, and engineering information. The Center is located in Fort Belvoir, VA.

E

EDPRT — Expert Diagnostic, Predictive, and Resolution Tools. EDPRT are being developed to support reliability–centered maintenance and to help isolate and solve equipment problems. They will do this by testing maintenance and reliability requirements and approaches for the EDPRT in operational environments.

EFF — Experimental Forecast Facility. The EFF provides rapid prototyping and operational capabilities to test new weather products. It is part of the National Oceanic and Atmospheric Administration and is located in Kansas City, KS.

ETMS — Enhanced Traffic Management System. ETMS is a multi–phase effort that has initially developed an Aircraft Situation Display (ASD) for graphically displaying current aircraft positions on a national scale. Further enhancements will include improved monitor and alert functions, automated rerouting capability, multiple airports scheduling capability, dynamic special use airspace status, and collaborative decision making.

EWR — International Civil Aviation Organization (ICAO) Designator for Newark Airport, Newark, NJ.

F

F&E — Facilities and Equipment. F&E is one of the three types of FAA budgetary classifications. It is the design and building phase for new/modified facilities, and the build and test phase for new/modified equipment.

FAA — Federal Aviation Administration.

FANS — Future Air Navigation System. FANS is an ICAO sponsored committee which has developed a global concept for communication, surveillance, navigation, and air traffic management.

FAR — Federal Aviation Regulations. These are the regulations developed and enforced by the FAA.

FBL	Fly–by–Light. FBL allows the pilot to use fiber optic light signals to control aircraft control surfaces and directly control aircraft motion.
FBW	Fly–by–Wire. FBW allows the pilot to use electrical signals to control aircraft control positions and directly control aircraft motion.
FDPR	Flight Data Processor Replacement. The FDPR replaces the oceanic display and processing system used in the oceanic program
FIS	Flight Information Services. FIS encompasses the pre–flight and inflight services provided primarily to general aviation.
FLOWSIM	Flow Simulation Model. FLOWSIM is a daily flow simulation model for airport traffic flow at the busiest airports in the country.
FMS	Flight Management System. FMS is an on–board aircraft system which provides navigation, guidance, performance monitoring, and flight planning functions.
FSM	Flight Schedule Monitor. The FSM monitors the difference in proposed and actual flight schedules as part of the Advanced Traffic Management System testbed.

G

GA	General Aviation. GA encompasses all civil aviation operations other than scheduled air services and nonscheduled services for hire.
GPRA	Government Performance and Results Act of 1993. The GPRA (P.L. 103–62) requires Federal agencies to prepare annual plans setting performance goals beginning with FY 1999.
GPS	Global Positioning System. The GPS is a satellite–based radionavigation, positioning and time transfer system that can provide a 100 meter accuracy position on earth.

H

HARS	High Altitude Route System. The HARS planning tool for traffic flow management will produce high altitude optimized fuel efficient jet routes.
HF	High Frequency. HF is the radio frequency band between 3 and 30 Megahertz (MHz).
HIRF	High Intensity Radiated Fields. HIRF are electromagnetic fields caused by equipment such as radars and radio transmitters, which may affect the avionics of aircraft.
HSCT	High–Speed Civil Transport. HSCT refers to future civil transport aircraft whose design criteria include carrying 300 passengers 5700 miles at 1600 mph.
HSI	Human Systems Integration. HSI refers to the integration of the human into all aspects of the development, design, acquisition, use, and maintenance of a system.

HUMS — Health and Usage Monitoring Systems. HUMS is a system that will determine optimal inspection/replacement intervals for aircraft. The major focus of the present effort is to apply HUMs to rotorcraft structures.

I

ICAO — International Civil Aviation Organization. ICAO is a specialized agency of the United Nations whose objectives are to develop the principles and techniques of international air navigation and to foster planning and development of civil air international transport.

ICTS — Icing Induced Tailplanes Stalls. ICTS refers to the susceptibility of commuter–class aircraft to stalls caused by ice on the horizontal plane of the tail.

IDEA — Innovation Development and Engineering Applications. This program provides the FAA with a formal structure to insure that innovative R,E&D proposed by FAA employees or the private sector will be evaluated, and if feasible, sponsored.

IFR — Instrument Flight Rules. These are FAR rules that cover the procedures for conducting instrument flight in IMC instrument flight.

IMC — Instrument Meteorological Conditions. ICAO has defined IMC as meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, less than the minima specified for visual meteorological conditions.

IR&D — Independent Research and Development. This program encourages contractors to perform independent research and development on topics relevant to FAA's long term interests.

ISDN — Integrated Services Digital Network – One of many open systems interface layers for transmitting digital data.

ISO — International Standards of Organization. ISO is a set of internationally approved telecommunications standards.

ITWS — Integrated Terminal Weather System. The ITWS is an automation system to be deployed at major airports that merges locally collected weather data and produces safety and planning forecast products (up to 30 minutes) to airport FAA air traffic management staffs.

J

JAA — Joint Airworthiness Authority. European equivalent of the FAA.

JFK — ICAO designator for John F. Kennedy International Airport, New York, NY.

JTA — Job Task Analysis. The JTA is a process that provides performance information on a user of a system or product relating to equipment procedures, personnel aptitudes, skill levels, job training, communication requirements, workspace, tools and equipment.

K

KRASH — KRASH is a software package for airframe structural analysis.

L

LAAS — Local Area Augmentation System. LAAS is a ground differential system designed to enhance the accuracy, availability, and integrity of the GPS signal to provide category II and III precision approaches.

LEOS — Low Earth Orbit Satellites – Satellites with orbital altitudes of seeral hundred miles used primarily for earth observance.

LGA — ICAO designator for LaGuardia Airport, New York, NY.

LIP — Limited Installation Program. LIP refers to a partial installation of a program – usually in an evaluation phase.

M

MEOS — Middle Earth Orbit Satellites – Satellites with orbital altitudes of several thousand miles used for communications and navigation (GPS).

Mode S — Mode Select. Mode S upgrades secondary radar systems that provide communications between pilots and air traffic controllers. Mode S's discreet addressing allows air traffic controllers to directly communicate with a specific pilot using data–link instead of voice communications.

MOPS — Minimum Operational Performance Standards. MOPS define the minimum technical requirements for development of design specifications for aircraft avionics.

N

NAS — National Airspace System. The NAS is the totality of all aviation operations in the U.S. and certain oceanic areas. The FAA has the principal responsibility for providing the NAS infrastructure. This responsibility extends from air traffic control to system security, and from safety to international coordination.

NASA — National Aeronautics and Space Administration.

NASPAC — National Airspace System Performance Analysis Capability. NASPAC simulates the performance of the NAS from a national perspective.

NASSIM — An executable engineering model of the NAS infrastructure.

NDI — Nondestructive Inspection. NDI refers to inspection techniques that do not affect the object being inspected, such as X–rays.

NEXRAD — Next Generation Weather Radar. Using Doppler radar technology the NEXRAD system observes the present speed and direction of motion of severe weather elements such as tornadoes and violent thunderstorms, and provides quantitative precipitation measurements.

NOAA — National Oceanic and Atmospheric Administration.

NSC — National Simulation Capability. The NSC program provides the capability to integrate future ATC subsystems during the conceptual stages of a product, permit early validation, problem identification and analysis, and provides system capability demonstrations.

NSTC — National Science and Technology Council. The Council assesses federal research and development priorities.

O

OAK — ICAO designator for Oakland International Airport, Oakland, CA.

OBIGGS — Onboard Inert Gas Generating System. The OBIGGS generates inert gases aboard aircraft as an alternative approach for fire suppression.

OCC — Operations Control Center. The OCC is an airways facility concept that draws together all operational information into a central domain.

ODL — Oceanic Data Link. The ODL allows direct controller/pilot data communications via satellite for aircraft flying ocean routes.

OPTIFLOW — Optimized Flow Planning Tool. OPTIFLOW provides optimized flow planning for dynamic national traffic flow optimization.

OSDS — Oceanic System and Development Support. The research and development for automation of the oceanic air traffic control system supports the initial objectives of the advanced oceanic automation system (AOAS) being developed and implemented through the OSDS contract effort and other related activities. The AOAS is the oceanic traffic management system which is being developed and fielded in phases over the next decade.

OSI — Open System Interface. OSI standards and protocols are being developed to assure compliance with international standards for communication systems.

OT&E — Operational Test and Evaluation. OT&E evaluates the operational effectiveness and suitability of a product.

P

PC	Personal Computer.
PCS	Personal Communications Systems – Includes such devices as cellular phones, pagers, and personal computer communications.
PLV	Power–lift Vehicle.
PRM	Precision Runway Monitor. The Multiple Runway Procedures Development Program is investigating the use of advanced surveillance techniques such as PRM technology, in conjunction with advanced avionics, for reducing parallel runway spacing standards to less than 3,400 feet.

R

RADS	Risk Analysis Decision Support. The RADS is the next version of the SPAS program (see below) and will provide computerized risk analysis tools for the aviation safety inspector.
RAMS	Reorganized Mathematical Air Traffic Control Simulator. The RAMS is a Eurocontrol developed simulation of controller task load.
R,E&D	Research, Engineering and Development.
RFP	Request for Proposal.
RNP	Required Navigation Performance. ICAO has defined the concept of RNP, as a statement of the navigation performance accuracy necessary for operation within a defined airspace.
RPD	Research Project Description.
RPM	Revenue Passenger Miles.
R–SDAT	Regional Airspace Sector Design Analysis Tool. See SDAT.
RTCA	RTCA Inc. is a non–profit corporation that functions as a Federal Advisory Committee on aviation issues.

S

SARPs	Standard and Recommended Practices. The SARPs are an internationally recognized set of practices developed by a number of ICAO expert panels covering all aspects of aviation. They are generally followed by all 183 countries in ICAO.

SATCOM	Satellite Communications. The SATCOM program will develop the standards and perform required testing to support mobile satellite communication (SATCOM) operational use as an oceanic subnetwork to the aeronautical network.
SATORI	Systematic Air Traffic Operations Research Initiative. The SATORI provides animation and simulation of data routinely collected on air traffic tapes which is used for a wide range of retrospective analyses.
SBIR	Small Business Innovation Research. This program uses small business to meet federal research and development needs. Research topics that are solicited by the agency appear in an annual solicitation for proposals by the Department of Transportation.
SDTF	SMA Development and Test Facility. Refer to SMA.
SFA	Survey Feedback Action. These are specific action items that result from an analysis of a survey.
SFO	ICAO designator for San Francisco International Airport, San Francisco, CA.
SIMMOD	SIMMOD is a trademark name for the FAA's Airport and Airspace and Simulation Model. It is a computer planning tool for airport designers and managers, air traffic planners and airlines. It is used to improve terminal area air traffic, as well as airport and airline ground operations.
SJC	ICAO designator for San Jose International Airport, San Jose, CA.
SLD	Large, super–cooled droplet icing condition.
SMA	Surface Movement Advisor. The SMA is an airport automation system which facilitates the sharing of information among the air traffic, airline, and airport operations management to augment decision making regarding the surface movement, of aircraft thus reducing intrusions and delays.
SMART FLOW	Knowledge–based Flow Planning Tool. SMARTFLOW is a knowledge–based tool for dynamic national traffic flow optimization.
SPAS	Safety Performance Analysis System. SPAS is an information system for aviation safety inspectors that contains safety–critical performance indicators on aircraft, air operators, air personnel, and air agencies.
SPEARS	Screener Proficiency Evaluation and Reporting System. SPEARS refers to a system which evaluates and enhance baggage screener performance and training.

T

TCA	Transport Canada
TCAS	Traffic Alert and Collision Avoidance. TCAS is a family of airborne devices that functions independently of the ground–based air traffic control system. TCAS uses air–to–air interrogations of transponder–equipped aircraft to provide collision avoidance protection.
TCCC	Tower Control Computer Complex. An automation platform that provides reconfigurable controller workstations.
TERPS	Terminal Instrument Procedures. These are the procedures that have been customized and approved by FAA at each airport for instrumented terminal approach and departures.
TFM	Traffic Flow Management. TFM refers to the process that allocates traffic flows to scarce capacity resources.
TRACON	Terminal Radar Approach Control. The TRACON provides information on the disposition of approaching aircraft within 60 miles of the terminal.
TRB	Transportation Research Board. The TRB is a National Research Council unit that serves the National Academy of Engineering.
TSO	Technical Standard Order. TSO's are the minimum performance standards for articles and equipment on aircraft.

U

U.S.	United States.
USWRP	United States Weather Research Program. The USWRP is a congressionally mandated weather program under the lead of the NOAA. The FAA will participate in the USWRP to address regional and local weather scale phenomena that are unique to aviation.

V

VHF	Very High Frequency. VHF is the radio frequency band between 30 and 300 Megahertz (Mhz).
VLCT	Very Large Commercial Transport. VLCT refers to future civil transport aircraft where design criteria include double–deck construction capable of carrying 800 to 1,000 passengers.
VOR	VHF Omnidirectional Range. The VOR is a ground–based radionavigation aid that provides bearing information from the station.

W

WAAS — Wide Area Augmentation System. WAAS is a network of reference stations, master control stations, ground earth stations, and communication satellites designed to enhance the accuracy, availability, and integrity of the GPS signal for all phases of flight including category I precision approaches.

APPENDIX D

Alphabetical Index of R,E&D Programs

APPENDIX E

Program Changes Since The 1996 R,E&D Plan

Programs that have been completed, renamed, combined, or withdrawn since the 1996 R,E&D Plan publication are listed below.

PROGRAM NUMBER	PROGRAM TITLE	LAST ACTIVITY
025–110	National Simulation Capability (NSC)	Withdrawn 1997
025–150	Free Flight Implementation	New Start 1998
027–110	NAS Telecommunications for the 21st Century	Withdrawn 1997
060–110	Aviation Safety Risk Analysis	New Project
061–110	Aircraft Systems Fire Safety to Fire Research and Safety	Name Change
067–110	Fire Research – Combined With Fire Research and Safety	Combined With 061–110
069–110	Cabin Safety – Combined With Fire Research and Safety	Combined With 061–110
081–110	Flight Deck Human Factors to Flight Deck/Aircraft Maintenance, System Integration Human Factors	Name Change
082–110	Air Traffic Control Human Factors to Air Traffic Services Human Factors	Name Change
083–110	Airway Facilities Human Factors – Combined With Air Traffic Services Human Factors	Combined With 082–110
084–110	Flightdeck/ATC System Integration – Combined With Flight Deck/Aircraft Maintenance, System Integration Human Factors	Combined With 082–110
085–110	Aircraft Maintenane Human Factors – Combined With Flight Deck/Aircraft Maintenance, System Integration Human Factors	Combined With 082–110

1997 Research, Engineering, and Development Plan Feedback

List below any suggestions on how you feel we might improve the Research, Engineering, and Development Plan (attach an extra sheet if necessary):

_____

_____

_____

_____

_____

Check One of the Boxes Below:

☐ **Add me to your mailing list:**

Point of Contact: _____
Organization: _____
Mailing Address: _____
_____
Number of Copies: _____

☐ **Remove me from your mailing list:**

Point of Contact: _____
Organization: _____
Mailing Address: _____
_____

☐ **Change the number of copies I now receive:**

Point of Contact: _____
Organization: _____
Mailing Address: _____
_____

☐ Increase Number of Copies to: _____

☐ Decrease Number of Copies to: _____

Detach Here

(Please Detach From Book, Fold, and Mail)

Fold Here *Fold Here* *Fold Here*

Affix Postage Here

Federal Aviation Administration
Office of Aviation Research
AAR-200
800 Independence Avenue, S.W.
Washington, D.C. 20591

ATTN: 1997 R,E&D Plan